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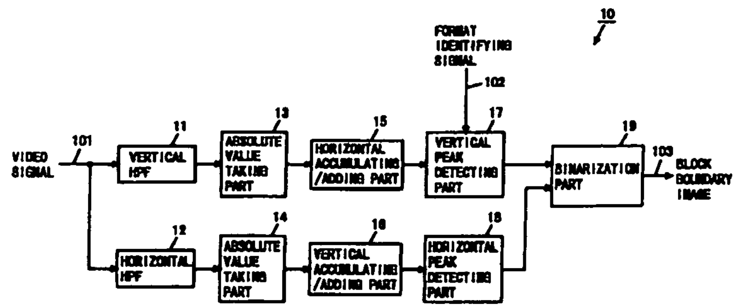
(54) BLOCK NOISE DETECTOR AND BLOCK NOISE ELIMINATOR

(57) A vertical HPF 11 and a horizontal HPF 12 receive a video signal 101, and extract only a high frequency component in the vertical/horizontal directions, respectively. Absolute value taking parts 13 and 14 take an absolute value thereof and change the value to a positive value. A horizontal accumulating/adding part 15 and a vertical accumulating/adding part 16 accumulate/add an input signal so as to output a vertical one-dimensional signal and a horizontal one-dimensional signal each periodically having a peak value in the vertical and horizontal directions. A horizontal peak detecting part 18 detects a horizontal peak position according to the horizontal one-dimensional signal. A vertical peak detecting part 17 detects a vertical peak position according to the vertical one-dimensional signal and identifies a format thereof. A binarization part 19 obtains a block boundary image, according to the horizontal peak position and the vertical peak position, in which pixel positions having a peak is provided with 1 and remaining pixel positions are provided with 0.

In this manner, even if a block boundary to eliminate block noise thereon is not clearly identified, it becomes possible to correctly detect and eliminate the block boundary.

FIG. 1



Description

TECHNICAL FIELD

[0001] The present invention relates to block noise detecting apparatuses and block noise eliminating apparatuses, more particularly to a block noise detecting apparatus and a block noise eliminating apparatus of a type eliminating block noise to be arisen in digital images as a result of image encoding carried out by compressing the digital images to transfer and record.

BACKGROUND ART

[0002] Data compression is conventionally done for digital images, for example, to store the same in less volume of data. Such data compression includes a lossless encoding method and a lossy encoding method. In the lossless encoding method, encoded data, after decoding, can be completely identical to data before encoding. On the other hand, in the lossy encoding method, encoded data, after decoding, cannot always be identical to data before encoding and may include an error in some degree.

[0003] The lossless encoding method generally includes discrete cosine transform (hereinafter, referred to as DCT). After DCT is carried out, quantization often follows. In this manner, when data is encoded first through DCT and then quantization, for example, the data cannot be completely identical to data before encoding and includes noise (error). It means that an encoding operation first through DCT and then quantization is lossy encoding.

[0004] To carry out DCT, first of all, a one-frame image is regionally divided into a plurality of blocks. A block herein is a group of 8 × 8 two-dimensional pixel data, for example, and is regarded as a unit. Data encoded through DCT and quantization can be reconstituted by being subjected to inverse quantization and inverse DCT. Through the inverse quantization and inverse DCT, image data including block noise can be reconstituted.

[0005] Herein, block noise is described by referring to FIG. 24.

[0006] FIG. 24 is a diagram illustrating a conventional concept in eliminating the block noise. FIG. 24(a) shows a one-frame image 701, FIG. 24(b) is an enlarged view of a partial boundary (hereinafter, referred to as block boundary) 706 between a block 704 and a block 705 adjacent thereto in FIG. 24(a), and FIG. 24(c) shows a state of pixels in FIG. 24(b) after being smoothed.

[0007] It is now assumed, in FIG. 24(a), that pixels are in line in specific blocks in the one-frame image 701. In FIG. 24(b), when a pixel **a** in the block 704 and pixel **b** in the block 705 are presumably bordering on the block boundary 706, a difference in pixel level therebetween being larger than a difference in in-block pixel level between a pixel **c** and pixel **d**, for example, causes the part to be block noise. Accordingly, image quality in the part will be degraded to a greater degree.

[0008] As is known from this, block noise results from a level difference between pixels bordering on a block boundary in one-frame image.

[0009] The block noise is common in the lossy encoding method including DCT and quantization where processing is carried out on a block basis. To eliminate noise arisen in images, generally, the images are entirely subjected to smoothing. Smoothing is an operation of determining a pixel in average by using various pixels around a pixel to be processed. An operation of smoothing images with a low-pass filter (hereinafter, referred to as LPF) having a few taps is also smoothing. Such smoothing can eliminate not only block noise but noise observed in images in their entirety as shown in FIG. 24(c).

[0010] Although there is no doubt that smoothing done on pixels can advantageously eliminate block noise, edges of images other than the block noise are also smoothed. Therefore, the images will disadvantageously be blurred.

[0011] Further, in the above conventional technique, the block noise can only be eliminated in a case where a block size and a block boundary are perfectly identified.

[0012] Still further, in a case where edges of images are bordering on the block boundary, the block noise causes less influence than the edges of the images. In the conventional technique in the foregoing, however, every block boundary is subjected to smoothing. In this manner, the edges of images bordering on the block boundary will be blurred, and thus smoothing done on the block boundary may degrade image quality to a greater degree.

[0013] Therefore, an object of the present invention is to provide a block noise detecting apparatus of a type correctly detecting a block boundary targeted to eliminate block noise even when that is not clearly identified.

[0014] Another object of the present invention is to provide a block noise eliminating apparatus of a type eliminating block noise without blurring images, not smoothing images even on a block boundary if block noise thereon is low, and best matching to visual scenes.

[0015] Still another object of the present invention is to provide a block noise eliminating apparatus of a type eliminating block noise observed in an input signal even if the input signal is an analog signal or external digital signal (DVD or STB, for example) in a multi-format (interlace system or progressive system, for example).

[0016] Further, a dot clock can be regenerated in a video processing system by using the block noise detecting apparatus of the present invention.

DISCLOSURE OF THE INVENTION

[0017] The present invention has the following features to attain the objects above.

[0018] A first aspect is directed to a block noise detecting apparatus of a type detecting, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise caused by decoding the video signal, the apparatus comprising:

means for detecting a level of the block noise in the video signal; and
means for detecting a block boundary (where the block noise is generated) in the video signal.

[0019] As described above, in the first aspect, by correctly detecting a block boundary of an image to be regionally divided into a plurality of blocks and a block noise level thereon, block noise can be detected.

[0020] A second aspect is directed to a block noise detecting apparatus of a type detecting, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise caused by decoding the video signal, the apparatus comprising:

signal extracting means for receiving the video signal and extracting only a high frequency component therefrom;
absolute value taking means for taking an absolute value of a high frequency component signal outputted from the signal extracting means;
accumulating/adding means for accumulating/adding the absolute-value-taken high frequency component signal outputted from the absolute value taking means in a predetermined period;
periodicity detecting means for detecting periodicity of the block noise in accordance with an accumulation/addition result outputted from the accumulating/adding means; and
block boundary determining means for determining a block boundary (where the block noise is generated) from a periodic signal detected by the periodicity detecting means.

[0021] As described above, in the second aspect, by detecting periodicity of block noise and by correctly detecting a block boundary of an image to be regionally divided into a plurality of blocks, the block noise can be detected.

[0022] According to a preferable and concretive third aspect, in the second aspect, the block boundary determining means distinguishes, in binary, between positional information on the block boundary and positional information on the rest. In this manner, a block boundary can be easily provided.

[0023] According to a fourth aspect, in the second and third aspects, the block noise detecting apparatus further comprises:

frame difference taking means for receiving the video signal and determining a signal difference among a plurality of predetermined frames thereof;
region determining means for determining, by referring to the signal difference outputted from the frame difference taking means for whether or not the difference is more than a predetermined threshold value, a region where the block noise to be eliminated is observed (hereinafter, referred to as noise region); and
block edge controlling means for masking the block boundary determined by the block boundary determining means in the noise region determined by the region determining means, and then determining a block boundary corresponding to the noise region.

[0024] As described above, in the fourth aspect, it becomes possible to further classify a block boundary compared to the second and third aspects by referring to the extent of image variation of images having block noise. As a result, only parts having high block noise observed in visual scenes can be detected as the block boundary.

[0025] According to a preferable and concretive fifth aspect, in the fourth aspect, the frame difference taking means determines a signal difference between a current frame and a one-frame-before frame. In this manner, only parts having high block noise observed in visual scenes can be detected as a block boundary.

[0026] According to a preferable and concretive sixth aspect, in the fourth and fifth aspects, the region determining means preferably distinguishes, in binary, between a part exceeding the threshold value and a part not exceeding the threshold value. In this manner, noise regions can be easily provided.

[0027] According to a seventh aspect, in the fourth to sixth aspects,

the block noise detecting apparatus further comprises singular point eliminating means for excluding a noise part observed in a predetermined small region of the noise region determined by the region determining means, wherein
the block edge controlling means masks the block boundary determined by the block boundary determining means in the noise-part-excluded noise region outputted from the singular point eliminating means.

[0028] As described above, in the seventh aspect, the smaller regions in the image, in the fourth to sixth aspects, where hardly benefit from noise elimination by smoothing are eliminated. In this manner, processing of taking frame difference can be enhanced and accordingly image quality is improved and data is reduced in volume.

[0029] According to a preferable eighth aspect, in the second to seventh aspects, the signal extracting

means, the absolute value taking means, the accumulating/adding means, and the periodicity detecting means each execute processing for the video signal in either horizontal or vertical direction, or both directions.

[0030] According to a ninth aspect, in the eighth aspect,

when each of the processing is executed for the video signal in the vertical direction,
the periodicity detecting means successively changes frames used for detection according to a format of the video signal to be inputted.

[0031] As described above, in the ninth aspect, a block boundary can be correctly detected without deteriorating periodicity of block image regardless of formats (interlace system/progressive system, for example) of a video signal to be inputted in eighth aspect.

[0032] A tenth aspect is directed to a block noise eliminating apparatus of a type detecting and eliminating, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise caused by decoding the video signal, the apparatus comprising:

means for detecting a level of the block noise in the video signal;
means for detecting a block boundary (where the block noise is generated) in the video signal; and
means for eliminating, in the block boundary, only the block noise whose the detected level is more than a predetermined threshold value.

[0033] As described above, in the tenth aspect, by correctly detecting a block boundary of an image to be regionally divided into a plurality of blocks and a block noise level thereon, the block noise can be detected. In this manner, block noise observed on the block boundary can be eliminated.

[0034] An eleventh aspect is directed to a block noise eliminating apparatus of a type detecting and eliminating, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise caused by decoding the video signal, the apparatus comprising:

signal extracting means for receiving the video signal and extracting only a high frequency component therefrom;
absolute value taking means for taking an absolute value of a high frequency component signal outputted from the signal extracting means;
accumulating/adding means for accumulating/adding the absolute-value-taken high frequency component signal outputted from the absolute value taking means in a predetermined period;
periodicity detecting means for detecting periodicity of the block noise in accordance with an accumulation/addition result outputted from the accumulating/adding means;
block boundary determining means for determining a block boundary (where the block noise is generated) from a periodic signal detected by the periodicity detecting means; and
block noise eliminating means for eliminating the block noise with respect to the block boundary.

[0035] As described above, in the eleventh aspect, by detecting periodicity of block noise and by correctly detecting a block boundary of an image to be regionally divided into a plurality of blocks, the block noise can be detected. In this manner, block noise observed on the block boundary can be eliminated.

[0036] According to a preferable and concretive twelfth aspect, in the eleventh aspect, the block boundary determining means distinguishes, in binary, between positional information on the block boundary and positional information on the rest. In this manner, a block boundary can be easily provided.

[0037] According to a thirteenth aspect, in the eleventh and twelfth aspects, the block noise eliminating apparatus further comprises:

frame difference taking means for receiving the video signal and determining a signal difference among a plurality of predetermined frames thereof;
region determining means for determining, by referring to the signal difference outputted from the frame difference taking means for whether or not the difference is more than a predetermined threshold value, a region where the block noise to be eliminated is observed (hereinafter, referred to as noise region); and
block edge controlling means for masking the block boundary determined by the block boundary determining means in the noise region determined by the region determining means, and then determining a block boundary corresponding to the noise region, wherein
the block noise eliminating means eliminates the block noise with respect to the block boundary corresponding to the noise region.

[0038] As described above, in the thirteenth aspect, it becomes possible to further classify a block boundary compared to the eleventh and twelfth aspects by referring to the extent of image variation of images having block noise. As a result, only parts having high block noise observed in visual scenes can be detected and eliminated as the block boundary.

[0039] According to a preferable and concretive fourteenth aspect, in the thirteenth aspect, the frame difference taking means preferably determines a signal difference between a current frame and a one-frame-before frame. In this manner, only parts having high block noise observed in visual scenes can be detected

and eliminated as the block boundary.

[0040] According to a preferable and concretive fifteenth aspect, in the thirteenth and fourteenth aspects, the region determining means distinguishes, in binary, between a part exceeding the threshold value and a part not exceeding the threshold value. In this manner, noise regions can be easily provided.

[0041] According to a sixteenth aspect, in the thirteenth to fifteenth aspects, the block noise eliminating means further comprises singular point eliminating means for excluding a noise part observed in a predetermined small region of the noise region determined by the region determining means, wherein

the block edge controlling means masks the block boundary determined by the block boundary determining means in the noise-part-excluded noise region outputted from the singular point eliminating means.

[0042] As described above, in the sixteenth aspect, the smaller regions in the image, in the thirteenth to fifteenth aspects, where hardly benefit from noise elimination by smoothing are eliminated. In this manner, processing of taking frame difference can be enhanced and accordingly image quality is improved and data is reduced in volume.

[0043] According to a preferable seventeenth aspect, in the eleventh to sixteenth aspects, the signal extracting means, the absolute value taking part, the accumulating/adding means, and the periodicity detecting means each preferably execute processing for the video signal in either horizontal or vertical direction, or both directions.

[0044] According to an eighteenth aspect, in the seventeenth aspect, the block noise eliminating apparatus further comprises identifying means for identifying a format for the video signal to be inputted, wherein

when each of the processing is executed for the video signal in the vertical direction,
the identifying means has the periodicity determining means successively change frames used for detection according to the format.

[0045] As described above, in the eighteenth aspect, a block boundary can be correctly detected without deteriorating periodicity of block image regardless of formats (interlace system/progressive system, for example) of a video signal to be inputted in seventeenth aspect.

[0046] A nineteenth aspect is directed to a block noise eliminating apparatus of a type detecting and eliminating, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise caused by decoding the video signal, the apparatus comprising:

vertical block boundary detecting means for receiving the video signal and detecting, with respect to the video signal, a block boundary (where the block noise is generated) in the lateral direction and a block noise level on a screen;
horizontal block boundary detecting means for receiving the video signal and detecting, with respect to the video signal, the block boundary in a longitudinal direction and block noise level on the screen;
block area detecting means for specifying the block boundary in both longitudinal and lateral directions from detection results of the vertical block boundary detecting means and the horizontal block boundary detecting means; and
block boundary smoothing means for smoothing the video signal to be inputted in a predetermined manner corresponding to the block boundary in both longitudinal and lateral directions specified by the block area detecting means.

[0047] As described above, in the nineteenth aspect, a block boundary and block noise level can be correctly detected. In this manner, smoothing can be properly done according to the block noise level, and thus block noise can be eliminated more effectively for the best match to the visual scenes.

[0048] According to a twentieth aspect showing the preferable and concretive structure, in the nineteenth aspect, the vertical block boundary detecting means comprises:

a vertical high-pass filter (hereinafter, referred to as HPF) extracting only a vertical high frequency component of the video signal;
first absolute value taking means for taking an absolute value of a high frequency component signal outputted from the vertical HPF;
horizontal accumulating/adding means for accumulating/adding the absolute-value-taken high frequency component signal outputted from the first absolute value taking means in the horizontal direction;
a first HPF again extracting high frequency component from the accumulated/added high frequency component signal outputted from the horizontal accumulating/adding means;
first N-point accumulating/adding means for accumulating/adding a signal outputted from the first HPF on a predetermined N-point basis (where N is a positive integer);
a first temporal filter detecting the block noise level of the video signal by computing the signal outputted from the first HPF in the temporal direction;
first maximum value detecting means for determining a maximum value and a position thereof among N-piece accumulated/added values determined by the first N-point accumulating/adding means

through accumulation/addition; and

first masking means for masking the block noise level detected by the first temporal filter at the position of the maximum value outputted from the first maximum value detecting means, and then determining a vertical block boundary corresponding to the position, wherein

the horizontal block boundary detecting means comprises:

a horizontal HPF extracting only a horizontal high frequency component of the video signal:

second absolute value taking means for taking an absolute value of a high frequency component signal outputted from the horizontal HPF;

vertical accumulating/adding means for accumulating/adding the absolute-value-taken high frequency component signal outputted from the second absolute value taking means in the vertical direction;

a second HPF again extracting high frequency component from the accumulated/added high frequency component signal outputted from the vertical accumulating/adding means;

N-point accumulating/adding means for accumulating/adding a signal outputted from the second HPF on a predetermined N-point basis;

a second temporal filter detecting the block noise level of the video signal by computing the signal outputted from the second HPF in the temporal direction;

second maximum value detecting means for determining a maximum value and a position thereof among the N-piece accumulated/added values determined by the second N-point accumulating/adding means through accumulation/addition; and

second masking means for masking the block noise level detected by the second temporal filter at the position of the maximum value outputted from the second maximum value detecting means and then determining a vertical block boundary corresponding to the position.

[0049] In this manner, it becomes possible to detect block noise level less in variation in the temporal direction, and to execute smoothing in an appropriate manner according to the block noise level. Accordingly, block noise can be eliminated more effectively for the best match to the visual scenes.

[0050] A twenty-first aspect is directed to a block noise eliminating apparatus of a type detecting and eliminating, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise caused by decoding the video signal, the apparatus comprising:

AD converting means for receiving the video signal in an analog fashion and then converting the same into a digital fashion;

digital decoding means for receiving the video signal in an encoded digital fashion for decoding and outputting the decoded block boundary information;

a selector receiving the video signal outputted from the AD converting means and the video signal outputted from the digital decoding means and selectively outputting either one of the video signals as is externally instructed;

vertical block boundary detecting means for receiving the video signal selected by the selector and detecting, with respect to the video signal, a block boundary (where the block noise is generated) in the lateral direction and a block noise level on a screen;

horizontal block boundary detecting means for receiving the video signal selected by the selector and detecting, with respect to the video signal, the block boundary in the longitudinal direction and the block noise level on a screen;

block area detecting means for specifying the block boundary in both longitudinal and lateral directions from detection results of the vertical block boundary detecting means and the horizontal block boundary detecting means; and

block boundary smoothing means for smoothing the video signal to be inputted in a predetermined manner corresponding to the block boundary in both longitudinal and lateral directions specified by the block area detecting means, wherein

the vertical block boundary detecting means and the horizontal block boundary detecting means output, to the block area detecting means, the block boundary based on each of the detection results when the selector selects the video signal outputted from the AD converting means, and output the block boundary based on the block boundary information outputted from the digital decoding means when the selector selects the video signal outputted from the digital decoding means.

[0051] As described above, in the twenty-first aspect, a block boundary and block noise level corresponding to a video signal to be inputted can be correctly detected. In this manner, smoothing can be done in a proper manner according to the block noise level, and thus block noise can be eliminated more effectively for the best match to the various visual scenes to be inputted.

[0052] According to a twenty-second aspect showing the preferable and concretive structure, in the twenty-first aspect,

the vertical block boundary detecting means preferably comprises:

a vertical high-pass filter (hereinafter, referred

to as HPF) extracting only a vertical high frequency component of the video signal;
first absolute value taking means for taking an absolute value of a high frequency component signal outputted from the vertical HPF;
horizontal accumulating/adding means for accumulating/adding the absolute-value-taken high frequency component signal outputted from the first absolute value taking means in the horizontal direction;
a first HPF again extracting high frequency component from the accumulated/added high frequency component signal outputted from the horizontal accumulating/adding means;
first N-point accumulating/adding means for accumulating/adding a signal outputted from the first HPF on a predetermined N-point basis (where N is a positive integer);
a first temporal filter detecting the block noise level of the video signal by computing the signal outputted from the first HPF in the temporal direction;
first maximum value detecting means for determining a maximum value and a position thereof among N-piece accumulated/added values determined by the first N-point accumulating/adding means through accumulation/addition;
a first selector synchronizing with the selector's selection and selectively outputting either one of the block boundary information outputted from the digital decoding means or the position of the maximum value outputted from the first maximum value detecting means; and
first masking means for masking the block noise level detected by the first temporal filter at the block boundary outputted from the first selector, and determining a vertical block boundary corresponding to the position, wherein

the horizontal block boundary detecting means comprises:

a horizontal HPF extracting only a horizontal high frequency component of the video signal;
second absolute value taking means for taking an absolute value of a high frequency component signal outputted from the horizontal HPF;
vertical accumulating/adding means for accumulating/adding the absolute-value-taken high frequency component signal outputted from the second absolute value taking means in the vertical direction;
a second HPF again extracting high frequency component from an accumulated/added high frequency component signal outputted from the vertical accumulating/adding means;
N-point accumulating/adding means for accumulating/adding a signal outputted from the second HPF on a predetermined N-point basis;
a second temporal filter detecting the block noise level of the video signal by computing the signal outputted from the second HPF in the temporal direction;
second maximum value detecting means for determining a maximum value and a position thereof among the N-piece accumulated/added values determined by the second N-point accumulating/adding means through accumulation/addition;
a second selector synchronizing with the selector's selection and selectively outputting either one of the block boundary information outputted from the digital decoding means or the position of the maximum value outputted from the second maximum value detecting means; and
second masking means for masking the block noise level detected by the second temporal filter at the block boundary outputted from the second selector, and determining a vertical block boundary corresponding to the position.

[0053] In this manner, it becomes possible to detect block noise level less in variation in the temporal direction, and to execute smoothing in an appropriate manner according to the block noise level. Accordingly, block noise can be eliminated more effectively for the best match to the various visual scenes to be inputted.

[0054] According to a twenty-third aspect showing the preferable and concretive structure, in the twentieth and twenty-second aspects,

the block boundary smoothing means preferably comprises:

a horizontal HPF extracting only a horizontal high frequency component of the video signal;
first multiplying means for multiplying an output of the horizontal HPF and an output of the horizontal block boundary detecting means;
first deducting means for deducting an output of the first multiplying means from the video signal;
a vertical HPF extracting only a vertical high frequency component of the video signal;
second multiplying means for multiplying an output of the vertical HPF and an output of the vertical block boundary detecting means; and
second deducting means for deducting an output of the second multiplying means from the video signal, wherein

the block noise is eliminated according to the block noise level.

[0055] In this manner, block noise can be effectively eliminated without deteriorating a video signal to be inputted.

[0056] According to a twenty-fourth aspect, in the nineteenth to twenty-third aspects, the block noise eliminating apparatus further comprises picture enhancing means for controlling a picture enhancement level emphasizing an outline part of the video signal according to the block noise level detected by the horizontal block boundary detecting means and the vertical block boundary detecting means.

[0057] As described above, in the twenty-fourth aspect, it becomes possible to properly carry out picture enhancement according to the block noise level, whereby picture enhancement of a video signal can be done without emphasizing block noise in the nineteenth to twenty-third aspects.

[0058] According to a twenty-fifth aspect, in the nineteenth to twenty-fourth aspects, the block noise eliminating apparatus further comprises controlling means for specifying the video signal (type or quality thereof, for example) to be inputted in accordance with the block noise level detected by the horizontal block boundary detecting means and the vertical block boundary detecting means, and

the controlling means on-screen-displays a result of the specification on a screen in a predetermined format.

[0059] As described above, in the twenty-fifth aspect, effects obtained by elimination of video sources or block noise can be acknowledged at a glance by on-screen-displaying information in the nineteenth to twenty-fourth aspects.

[0060] A twenty-sixth aspect is directed to a vertical block boundary detecting apparatus of a type detecting, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise in the vertical direction caused by decoding the video signal, the apparatus comprising:

a vertical high-pass filter (hereinafter, referred to as HPF) receiving the video signal and extracting only a vertical high frequency component of the video signal;
absolute value taking means for taking an absolute value of a high frequency component signal outputted from the vertical HPF;
horizontal accumulating/adding means for accumulating/adding the absolute-value-taken high frequency component signal outputted from the absolute value taking means in the horizontal direction;
an HPF again extracting high frequency component from the accumulated/added high frequency component signal outputted from the horizontal accumulating/adding means;
N-point accumulating/adding means for accumulating/adding a signal outputted from the HPF on a predetermined N-point basis (where N is a positive integer);
a temporal filter detecting the block noise level of the video signal by computing the signal outputted from the HPF in the temporal direction;
maximum value detecting means for determining a maximum value and a position thereof among N-piece accumulated/added values determined by the N-point accumulating/adding means through accumulation/addition; and
masking means for masking the block noise level detected by the temporal filter at the position of the maximum value outputted from the maximum value detecting means, and determining a vertical block boundary corresponding to the position.

[0061] As described above, in the twenty-sixth aspect, a device for detecting a block boundary in the vertical direction is structured separately.

[0062] A twenty-seventh aspect is directed to a horizontal block boundary detecting apparatus of a type detecting, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise in the horizontal direction caused by decoding the video signal, the apparatus comprising:

a horizontal high-pass filter (hereinafter, referred to as HPF) receiving the video signal and extracting only a vertical high frequency component of the video signal;
absolute value taking means for taking an absolute value of a high frequency component signal outputted from the horizontal HPF;
vertical accumulating/adding means for accumulating/adding the absolute-value-taken high frequency component signal outputted from the absolute value taking means in the vertical direction;
an HPF again extracting high frequency component from the accumulated/added high frequency component signal outputted from the vertical accumulating/adding means;
N-point accumulating/adding means for accumulating/adding a signal outputted from the HPF on a predetermined N-point basis (where N is a positive integer);
a temporal filter detecting the block noise level of the video signal by computing the signal outputted from the HPF in the temporal direction;
maximum value detecting means for determining a maximum value and a position thereof among N-piece accumulated/added values determined by the N-point accumulating/adding means through accumulation/addition; and
masking means for masking the block noise level detected by the temporal filter at the position of the maximum value outputted from the maximum value

detecting means, and determining a horizontal block boundary corresponding to the position.

[0063] As described above, in the twenty-seventh aspect, a device for detecting a block boundary in the horizontal direction is structured separately.

[0064] A twenty-eighth aspect is directed to a dot clock controlling apparatus of a type controlling a dot clock to be regenerated in a video processing system in which a digital video signal subjected to lossy encoding on a predetermined image block basis is processed, the apparatus comprising:

clock generating means for generating the dot clock used in the video processing system in accordance with a horizontal synchronizing pulse;
horizontal block boundary detecting means for receiving the video signal and detecting a longitudinal block boundary (where block noise is generated) on a screen with respect to the video signal; and
controlling means for changing delay of the clock generating means in such a manner that the block boundary detected by the horizontal block boundary detecting means periodically has a single maximum point (peak).

[0065] As described above, in the twenty-eighth aspect, a horizontal block boundary corresponding to the video signal to be inputted are detected, and then a dot clock is regenerated according to positions thereof. In this manner, a clock whose phase is coincided with that of a dot clock of the video signal can be correctly regenerated.

[0066] According to a twenty-ninth aspect showing the preferable and concretive structure, in the twenty-eighth aspect, the horizontal block boundary detecting means comprises:

a horizontal high-pass filter (hereinafter, referred to as HPF) receiving the video signal and extracting only a vertical high frequency component of the video signal;
absolute value taking means for taking an absolute value of a high frequency component signal outputted from the horizontal HPF;

vertical accumulating/adding means for accumulating/adding the absolute-value-taken high frequency component signal outputted from the absolute value taking means in the vertical direction;
an HPF again extracting high frequency component from the accumulated/added high frequency component signal outputted from the vertical accumulating/adding means; and
N-point accumulating/adding means for accumulating/adding a signal outputted from the HPF on a predetermined N-point basis (where N is a positive integer).

[0067] In this manner, it becomes possible to correctly regenerate a clock whose phase is coincided with that of a dot clock of the video signal.

[0068] A thirtieth aspect is directed to a recording medium containing a program recorded thereon, to be run in a computer device, for detecting block noise from a digital video signal subjected to lossy encoding on a predetermined image block basis caused by decoding the video signal, the program for realizing an operational environment on the computer device comprising the steps of:

extracting only a high frequency component from the video signal;
taking an absolute value of the extracted high frequency component signal;
accumulating/adding the absolute-value-taken high frequency component signal in a predetermined period;
detecting periodicity of the block noise in accordance with the accumulation/addition result; and
determining a block boundary (where the block noise id generated) in accordance with a signal having the detected periodicity.

[0069] According to a thirty-first aspect, in the thirtieth aspect, the program further comprises a step of eliminating the block noise with respect to the block boundary.

[0070] According to a preferable and concretive thirty-second aspect, in the thirtieth and thirty-first aspects, in the step of determining the block boundary, positional information on the block boundary and positional information on the rest are distinguished, in binary, from each other.

[0071] According to a thirty-third aspect, in the thirtieth to thirty-second aspects, the program further comprises the steps of:

determining a signal difference among a plurality of predetermined frames of the video signal;
determining a region where block noise to be eliminated is observed (hereinafter, referred to as noise region) with reference whether or not the signal difference is larger than a predetermined threshold value; and
masking the block boundary in the noise region, and determining a block boundary corresponding to the noise region.

[0072] According to a preferable and concretive thirty-fourth aspect, in the thirty-third aspect, in the step of determining the signal difference, a signal difference between a current frame and a one-before-frame is determined.

[0073] According to a preferable and concretive thirty-fifth aspect, in the thirty-third to thirty-fourth aspects, in the step of determining the noise region, a part exceeding the threshold value and a part not exceeding the threshold value are distinguished, in binary, from each other.

[0074] According to a thirty-sixth aspect, in the thirty-third to thirty-fifth aspects, the recording medium further comprises a step of eliminating a noise part in a predetermined small region of the noise region, wherein

in the step of determining a block boundary corresponding to the noise block, the block boundary is masked in the noise-part-eliminated noise region.

[0075] According to a preferable and concretive thirty-seventh aspect, in the thirtieth to thirty-sixth aspects, each of the steps is executed in either horizontal direction or vertical direction of the video signal, or in both directions.

[0076] According to a thirty-eighth aspect, in the thirty-seventh aspect, when each of the processing is executed in the vertical direction of the video signal,

in the step of detecting periodicity, frames used for detection are successively changed corresponding to a format of the video signal to be inputted.

[0077] A thirty-ninth aspect is directed to a recording medium containing a program recorded thereon, to be run in a computer device, for detecting block noise from a digital video signal subjected to lossy encoding on a predetermined image block basis caused by decoding the video signal, the program for realizing an operational environment on the computer device comprising the steps of:

detecting, with respect to the video signal, a block boundary (where the block boundary is generated) in the lateral direction and a block noise level on the screen;
detecting, with respect to the video signal, the block boundary in the longitudinal direction and block noise level on the screen;
specifying the block boundary in both longitudinal and lateral directions from a detection result obtained in the step of detecting as to the lateral direction and the step of detecting as to the longitudinal direction; and
smoothing the video signal in a predetermined manner corresponding to the block boundary in both longitudinal and lateral directions.

[0078] According to a fortieth aspect showing the preferable and concretive technique, in the thirty-ninth aspect,

the step of detecting as to the lateral direction comprises the steps of:

extracting only a vertical high frequency component from the video signal;
taking an absolute value of the extracted high frequency component signal;
accumulating/adding the absolute-value-taken high frequency component signal in the horizontal direction;
again extracting high frequency component from the accumulated /added high frequency component signal;
accumulating/adding a signal outputted in the step of again extracting high frequency component on a predetermined N-point basis (N is a positive integer);
detecting the block noise level of the video signal by computing the signal outputted in the step of again extracting high frequency component in the temporal direction;
determining a maximum value and a position thereof among N-piece accumulated/added values determined by the accumulation/addition; and
masking the detected block noise level at the position of the maximum value, and determining a vertical block boundary corresponding to the position, and

the step of detecting as to the longitudinal direction comprises the steps of:

extracting only a horizontal high frequency component of the video signal;
taking an absolute value of the extracted high frequency component signal;
accumulating/adding the absolute-value-taken high frequency component signal in the vertical direction;
again extracting high frequency component from the accumulated/added high frequency component signal;
accumulating/adding a signal outputted in the step of again extracting high frequency component on a predetermined N-point basis;
detecting the block noise level of the video signal by computing the signal outputted in the step of again extracting high frequency component in the temporal direction;
determining a maximum value and a position thereof among the N-piece accumulated/added values determined by the accumulation/addition; and
masking the detected block noise level at the position of the maximum value, and determining a vertical block boundary corresponding to the position.

[0079] A forty-first aspect is directed to a recording medium containing a program recorded thereon, to be run in a computer device, for detecting block noise from a digital video signal subjected to lossy encoding on a predetermined image block basis caused by decoding the video signal, the program for realizing an operational environment on the computer device further comprising the steps of:

converting the video signal in an analog fashion into a digital fashion;
decoding the digital-encoded video signal;
outputting the decoded block boundary information;
selecting either one of a video signal outputted in the converting step or a video signal outputted in the decoding step as is externally instructed:
detecting a lateral block boundary on a screen and a block noise level with respect to the video signal outputted in the selecting step;
detecting a longitudinal block boundary on a screen and a block noise level with respect to the video signal outputted in the selecting step;
specifying the block boundary in both longitudinal and lateral directions from detection results obtained in the step of detecting the lateral direction and the step of detecting the longitudinal direction; and
smoothing the video signal in a predetermined manner according to the block boundary in both longitudinal and lateral directions, wherein
in the step of detecting as to lateral direction and the step of detecting as to longitudinal direction, the block boundary based on each of the detection results is outputted for the video signal outputted in the converting step, and the block boundary based on the decoded block boundary information are outputted for the video signal outputted in the decoding step.

[0080] According to a forty-second aspect showing the preferable and concretive technique, in the forty-first aspect, the step of detecting as to the lateral direction comprises the steps of:

extracting only a vertical high frequency component of the video signal;
taking an absolute value of the extracted high frequency component signal;
accumulating/adding the absolute-value-taken high frequency component signal in the horizontal direction ;
again extracting high frequency component from the accumulated /added high frequency component signal;
accumulating/adding a signal outputted in the step of again extracting high frequency component on a predetermined N-point basis (n is a positive integer);
detecting the block noise level of the video signal by computing the signal outputted in the step of again extracting high frequency component in the temporal direction;
determining a maximum value and a position thereof among N-piece accumulated/added values determined by the accumulation/addition; and
synchronizing with the selecting step, and selectively outputting either one of the block boundary information and the maximum value position; and
masking the block noise level at the block boundary outputted in the selectively outputting step, and determining a vertical block boundary corresponding to the position, and

the step of detecting as to longitudinal direction comprises the steps of:

extracting only a horizontal high frequency component of the video signal:
taking an absolute value of the extracted high frequency component signal;
accumulating/adding the absolute-value-taken high frequency component signal in the vertical direction ;
again extracting high frequency component from the accumulated /added high frequency component signal;
accumulating/adding a signal outputted in the step of again extracting high frequency component on a predetermined N-point basis;
detecting the block noise level of the video signal by computing the signal outputted in the step of again extracting high frequency component in the temporal direction;
determining a maximum value and a position thereof among the N-piece accumulated/added values determined by the accumulation/addition; and
synchronizing with the selecting step, and selectively outputting either one of the block boundary information or the position of the maximum value; and
masking the block noise level at the block boundary outputted in the selectively outputting step, and determining a horizontal block boundary corresponding to the position.

[0081] According to a forty-third aspect, in the fortieth and forty-second aspects,

the smoothing step further comprises:

a horizontal step of extracting only a horizontal high frequency component of the video signal;
a horizontal multiplying step of multiplying an output in the horizontal step and an output in the longitudinal detecting step;
a step of deducting an output in the horizontal

multiplying step from the video signal;

a vertical step of extracting only a vertical high frequency component of the video signal;

a vertical multiplying step of multiplying an output in the vertical step and an output in the lateral detecting step; and

a step of deducting an output in the vertical multiplying step from the video signal, wherein

the block noise is eliminated according to the block noise level.

[0082] According to a forty-fourth aspect, in the thirty-ninth to forty-third aspects,

the program further comprising a step of controlling an picture enhancement level emphasizing an outline of the video signal according to the block noise level detected in the step of detecting as to the longitudinal direction and the step of detecting as to the lateral direction.

[0083] According to a forty-fifth aspect, in the thirty-ninth to forth-fourth aspects, the program further comprises a step of specifying the video signal (types or quality thereof, for example) to be inputted in accordance with the block noise level detected in the step of detecting as to longitudinal direction and the step of detecting as to the lateral direction, wherein

in the specifying step, the specification result is on-screen-displayed on a screen in a predetermined format.

[0084] A forth-sixth aspect is directed to a recording medium containing a program recorded thereon, to be run in a computer device, for detecting block noise in the vertical or horizontal direction from a digital video signal subjected to lossy encoding on a predetermined image block basis caused by decoding the video signal, the program for realizing an operational environment on the computer device comprising the steps of:

extracting only a vertical or horizontal high frequency component of the video signal;

taking an absolute value of the extracted high frequency component signal;

accumulating/adding the absolute-value- taken high frequency component signal in the horizontal or vertical direction;

again extracting high frequency component from the accumulated/added high frequency component signal;

accumulating/adding a signal outputted in the step of again extracting high frequency component on a predetermined N-point basis (N is a positive integer);

detecting the block noise level of the video signal by computing the signal outputted in the step of again extracting high frequency component in the temporal direction;

determining a maximum value and a position thereof among N-piece accumulated/added values determined by the accumulation/addition; and

masking the detected block noise level at the position of the maximum value, and determining a vertical or horizontal block boundary corresponding to the position.

[0085] A forty-seventh aspect is directed to a recording medium containing a program recorded thereon, to be run in a computer device, for controlling a dot clock to be regenerated in a video processing system in which a digital video signal subjected to lossy encoding on a predetermined image block basis is processed, the program for realizing an operational environment on the computer device comprising the steps of:

receiving the video signal, and detecting, with respect to the video signal, a block boundary (where block noise is generated) in the longitudinal direction on a screen; and

changing clock delay in such a manner that the block boundary detected in the step periodically has a single maximum point (peak) with respect to a clock generating device in which the dot clock used for the video processing system is generated based on a horizontal synchronizing pulse.

[0086] According to a forty-eighth aspect showing the preferable and concretive technique, in the forty-seventh aspect, the detecting step further comprises the steps of:

extracting only a horizontal high frequency component of the video signal;

taking an absolute value of the extracted high frequency component signal;

accumulating/adding the absolute-value-taken high frequency component signal in the vertical direction;

again extracting high frequency component from the accumulated/added high frequency component signal; and

accumulating/adding the signal outputted in the step of again extracting high frequency component on a predetermined N-point basis (N is a positive integer).

[0087] As described above, the thirtieth to forty-eighth aspects are directed to a recording medium on which a computer program for executing each function realized by each device in the first to twenty-ninth aspects is recorded. This is for supplying the first to twenty-ninth aspects in the form of software for an existing device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0088]

FIG. 1 is a block diagram showing the structure of a block noise detecting apparatus 10 according to a first embodiment of the present invention.
FIG. 2 is a diagram illustrating how a vertical HPF 11, a horizontal HPF 12, absolute value taking parts 13 and 14, a horizontal accumulating/adding part 15, and a vertical accumulating/adding part 16 in FIG. 1 are operated.
FIG. 3 is a diagram exemplarily illustrating how a horizontal peak detecting part 18 (and a vertical peak detecting part 17) in FIG. 1 is operated.
FIG. 4 is a diagram illustrating how a binarization part 19 in FIG. 1 is operated.
FIG. 5 is a block diagram showing the structure of a block noise detecting apparatus 20 according to a second embodiment of the present invention.
FIG. 6 is a diagram exemplarily illustrating how a singular point eliminating part 24 in FIG. 5 is operated.
FIG. 7 is a diagram exemplarily illustrating how a BE controlling part 31 in FIG. 5 is operated.
FIG. 8 is a block diagram showing the structure of a block noise eliminating apparatus 30 according to a third embodiment of the present invention.
FIG. 9 is a block diagram exemplarily showing the structure of a format identifying circuit 31 in FIG. 8.
FIG. 10 is a block diagram exemplarily showing the structure of a block noise eliminating circuit 32 in FIG. 8.
FIG. 11 is a diagram exemplarily illustrating how the block noise eliminating circuit 32 in FIG. 8 executes smoothing processing.
FIG. 12 is a block diagram showing the structure of a block noise eliminating apparatus 40 according to a fourth embodiment of the present invention.
FIG. 13 is a block diagram exemplarily showing the structure of a horizontal block boundary detecting part 41 in FIG. 12.
FIG. 14 is a block diagram exemplarily showing the structure of a vertical block boundary detecting part 42 in FIG. 12.
FIG. 15 is a block diagram exemplarily showing the structure of a block boundary smoothing part 44 in FIG. 12.
FIG. 16 is a block diagram exemplarily showing the structure of a picture enhancing part 45 in FIG. 12.
FIG. 17 is a block diagram showing the structure of a block noise eliminating apparatus 50 according to a fifth embodiment of the present invention.
FIG. 18 is a block diagram exemplarily showing the structure of a horizontal block boundary detecting part 54 in FIG. 17.
FIG. 19 is a block diagram exemplarily showing the structure of a vertical block boundary detecting part 55 in FIG. 17.
FIG. 20 is a block diagram showing the structure of a dot clock detecting apparatus 60 according to a sixth embodiment of the present invention.
FIG. 21 is a block diagram exemplarily showing the structure of a horizontal block boundary detecting part 64 in FIG. 20.
FIG. 22 is a diagram exemplarily showing an accumulation/addition result of horizontal block noise outputted from the horizontal block boundary detecting part 64 in FIG. 20.
FIG. 23 is a diagram illustrating how a video signal 601 and a clock (CK) are related to each other.
FIG. 24 is a diagram illustrating a conventional concept in eliminating block noise.

BEST MODE FOR CARRYING OUT THE INVENTION

[0089] Hereinafter, a block noise detecting apparatus and a block noise eliminating apparatus of the present invention are described next below on a functional block basis.

(First Embodiment)

[0090] FIG. 1 is a block diagram showing the structure of a block noise detecting apparatus according to a first embodiment of the present invention. In FIG. 1, a block noise detecting apparatus 10 of the first embodiment is structured by a vertical high-pass filter (hereinafter, referred to as vertical HPF) 11, a horizontal high-pass filter (hereinafter, referred to as horizontal HPF) 12, absolute value taking parts 13 and 14, a horizontal accumulating/adding part 15, a vertical accumulating/adding part 16, a vertical peak detecting part 17, a horizontal peak detecting part 18, and a binarization part 19.

[0091] FIG. 2 is a diagram illustrating how each of the vertical HPF 11, horizontal HPF 12, absolute value taking parts 13 and 14, horizontal accumulating/adding part 15, and vertical accumulating/adding part 16 in FIG. 1 is operated.

[0092] FIG. 3 is a diagram exemplarily illustrating how the horizontal peak detecting part 18 (and the vertical peak detecting part 17) in FIG. 1 is operated. Note that, FIG. 3(a) shows a horizontal one-dimensional signal 115 outputted from the vertical accumulating/adding part 16, and FIG. 3(b) shows a horizontal peak position 122 outputted from the horizontal peak detecting part 18.

[0093] FIG. 4 is a diagram illustrating how the binarization part 19 in FIG. 1 is operated. Note that, FIG. 4(a) shows the horizontal peak position 122 and a horizontal binary image 124, FIG. 4(b) shows a vertical peak position 123 and a vertical binary image 125, and FIG. 4(c) shows a block boundary image 103 outputted from the binarization part 19.

[0094] Hereinafter, by referring to FIG. 1 to FIG. 4, it

is described stepwise how the block noise detecting apparatus 10 according to the first embodiment of the present invention is operated.

[0095] A video signal is, in general, a signal obtained by one-dimensionally positioning three-dimensionally structured (horizontal/vertical/temporal) dynamic image data. A video signal 101 in the present invention is a one-frame image 112 being a two-dimensional video signal both in the horizontal and vertical directions of one-frame time unit obtained in accordance with the above-described video signal, and also is a signal transmitted at a constant rate. In the one-frame image 112, as shown in FIG. 2, block images 113 are uniformly positioned in the horizontal and vertical directions, and each thereof includes block noise 114 in both directions. The block noise 114 periodically appears, as shown in FIG. 2, in the horizontal and vertical directions. Such video signal 101 is inputted into the vertical HPF 11 and horizontal HPF 12, respectively.

[0096] The vertical HPF 11 receives the video signal 101, and extracts only high frequency components in the vertical direction. The absolute value taking part 13 receives a signal outputted from the vertical HPF 11, and takes an absolute value thereof so as to change the value to a positive value. The horizontal accumulating/adding part 15 receives a signal outputted from the absolute value taking part 13, and performs accumulation/addition so as to output a vertical one-dimensional signal 116 periodically having a peak value in the vertical direction. On the other hand, the horizontal HPF 12 receives the video signal 101, and extracts only high frequency components in the horizontal direction. The absolute value taking part 14 receives a signal outputted from the horizontal HPF 12, and takes an absolute value thereof so as to change the value to a positive value. The vertical accumulating/adding part 16 receives a signal outputted from the absolute value taking part 14, and performs accumulation/addition so as to output the horizontal one-dimensional signal 115 periodically having a peak value in the horizontal direction.

[0097] The horizontal peak detecting part 18 detects a horizontal peak position in accordance with the horizontal one-dimensional signal 115 outputted from the vertical accumulating/adding part 16. It is now exemplarily described how the horizontal peak detecting part 18 detects the horizontal peak position by referring to FIG. 3.

[0098] First, the horizontal peak detecting part 18 selects a detection region 119 (FIG. 3(a)) which is an arbitrary pixel range including three block boundary lines (about 30 pixels when the block size is 8) from the horizontal one-dimensional signal 115. Next, the horizontal peak detecting part 18 detects three data higher in an accumulation/addition level in the selected detection region 119 as peak positions. A difference among these detected peak positions is a block size in the horizontal direction. Hereinafter, the horizontal peak detecting part 18 makes a lateral move in the detection region 119 with spacing of the block size in the horizontal direction, and then detects each peak position so as to determine the horizontal peak position 122 as shown in FIG. 3(b).

[0099] The vertical peak detecting part 17 detects a vertical peak position according to the vertical one-dimensional signal 116 outputted from the horizontal accumulating/adding part 15. Note that, the vertical peak detecting part 17 detects the vertical peak position in a similar manner to the horizontal peak detecting part 18 for the horizontal peak position, and thus an operation thereof is not described again. The vertical peak detecting part 17 determines the vertical peak position 123 as shown in FIG. 4(b).

[0100] When a format for the video signal 101 is interlace system, peak positions of the vertical one-dimensional signal 116 outputted from the horizontal accumulating/adding part 15 may differ in even-numbered fields and odd-numbered fields. If the vertical peak detecting part 17 detects peak positions in the aforementioned manner without distinguishing between the even-numbered fields and odd-numbered fields, the vertical peak position 123 cannot be correct. Therefore, the vertical peak detecting part 17 externally receives a format identifying signal 102 relevant to the video signal 101. If judged that the format is interlace system, the vertical peak detecting part 17 detects peak positions separately for the even-numbered fields and odd-numbered fields so as to determine the vertical peak position 123 for the respective fields.

[0101] The binarization part 19 receives the horizontal peak position 122 outputted from the horizontal peak detecting part 18 and the vertical peak position 123 outputted from the vertical peak detecting part 17. The binarization part 19 provides, in accordance with the horizontal peak position 122, a logical value of "1" for each pixel position where the peak is, and provides a logical value of "0" for the remaining pixel positions, and then generates a horizontal binary image 124 in the same size as the one-frame image 112 (FIG. 4(a)). Further, the binarization part 19 provides, in accordance with the vertical peak position 123, the logical value of "1" for each pixel position where the peak is, and provides the logical value of "0" for the remaining pixel positions, and then generates a vertical binary image 125 in the same size as the one-frame image 112 (FIG. 4(b)). Thereafter, the binarization part 19 does OR for the horizontal binary image 124 and vertical binary image 125 so as to determine a block boundary image 103 (FIG. 4(c)).

[0102] In the block boundary image 103, a part having the logical value of "1" is the block boundary part, that is, where the block noise 114 arises.

[0103] As is known from the above, the block noise detecting apparatus 10 according to the first embodiment of the present invention can correctly detect a block boundary (block boundary image 103) of an

image regionally divided into a plurality of blocks. Further, with respect to the video signal 101 whose format is interlace system, the block noise 114 can be correctly detected without deteriorating periodicity of the block image 113.

(Second Embodiment)

[0104] FIG. 5 is a block diagram showing the structure of a block noise detecting apparatus according to a second embodiment of the present invention. In FIG. 5, a block noise detecting apparatus 20 of the second embodiment is structured by the vertical HPF 11, the horizontal HPF 12, the absolute value taking parts 13 and 14, the horizontal accumulating/adding part 15, the vertical accumulating/adding part 16, the vertical peak detecting part 17, the horizontal peak detecting part 18, the binarization part 19, a frame difference taking part 21, a frame memory 22, a binarization part 23, a singular point eliminating part 24, and a block edge controlling part (hereinafter, referred to as BE controlling part) 25.

[0105] Note that, the block noise detecting apparatus 20 of the second embodiment and the block noise detecting apparatus 10 of the first embodiment are identical in the vertical HPF 11, horizontal HPF 12, absolute value taking parts 13 and 14, horizontal accumulating/adding part 15, vertical accumulating/adding part 16, vertical peak detecting part 17, horizontal peak detecting part 18, and binarization part 19. Therefore, those components are provided with the same reference numerals and are not described again.

[0106] FIG. 6 is a diagram exemplarily illustrating how the singular point eliminating part 24 in FIG. 5 is operated. Note that, FIG. 6(a) shows an image 233 outputted from the binarization part 23, singular points in which are to be eliminated, and FIG. 6(b) shows a singular-point-eliminated image 234 outputted from the singular point eliminating part 24.

[0107] FIG. 7 is a diagram exemplarily illustrating how the BE controlling part 31 in FIG. 5 is operated. Note that, FIG. 8(a) shows the block boundary image 103 outputted from the binarization part 19, FIG. 8(b) shows the singular-point-eliminated image 234 outputted from the singular point eliminating part 24, and FIG. 8(c) shows an image 235 after being subjected to BE control.

[0108] Hereinafter, by referring to FIG. 5 to FIG. 7, it is described stepwise how the block noise detecting apparatus 20 according to the second embodiment of the present invention is operated.

[0109] The video signal 101 is inputted into the frame difference taking part 21. First of all, the frame difference taking part 21 takes a difference in signal level between the inputted video signal 101 and another one-frame-before video signal 101 stored in the frame memory 22 as a difference. Herein, in an initial state (a state in which the frame memory 22 in the activated block noise detecting apparatus 20 has nothing stored) of the frame difference taking part 21, only an storage operation for the frame memory 22 is carried out. Thereafter, the frame difference taking part 21 judges whether or not the difference is equal to or larger than a predetermined threshold value, and then outputs areas to the binarization part 23 only when the difference is equal to or larger than the threshold value. In this manner, through such processing by the frame difference taking part 21, only scenes having the large extent of the image variation in the video signal 101 can be outputted. Note that, a level of the threshold value can be arbitrarily determined according to the desired image quality.

[0110] After outputting the difference areas to the binarization part 23, the frame difference taking part 21 stores the video signal 101 in the current frame into the frame memory 22. Thereafter, the frame difference taking part 21 repeats the above-described processing every time the part receives a new frame.

[0111] The binarizarion part 23 receives the difference areas outputted from the frame difference taking part 21. Then, in the one-frame image 112, the binarization part 23 provides the logical value of "1" for each pixel position where the difference is (singular point), and the logical value of "0" for the remaining pixel positions without the difference. In this manner, the singular-point-to-be-eliminated image 233 in FIG. 6(a) is obtained. Note that, the shaded and dotted parts in FIG. 6(a) are the pixel positions having the logical value of "1".

[0112] The singular point eliminating part 24 receives the singular-point-to-be-eliminated image 233 (FIG. 6(a)) from the binarization part 23, and a block size from the binarization part 19. Thereafter, the singular point eliminating part 24 eliminates, from the singular-point-to-be-eliminated image 233, data having the logical value of "1" observed in regions smaller than one block size (regions indicated by wiggled lines in FIG. 6). In this manner, the singular-point-eliminated image 234 in FIG. 6(b) is obtained.

[0113] The reason why singular point data is eliminated is as follows. The smaller regions in the singular-point-to-be-eliminated image 233 may not benefit from to-be-done noise elimination, but the noise elimination may smooth data and then blur images. Therefore, removing those smaller regions as singular points results in higher image quality.

[0114] Accordingly, the singular point eliminating part 24 effectively enhances frame difference processing, and volume of data can be also reduced.

[0115] The BE controlling part 25 receives the block boundary image 103 (FIG. 7(a)) outputted from the binarization part 19 and the singular-point-eliminated image 234 (FIG. 7(b)) outputted from the singular point eliminating part 24. The BE controlling part 25 does AND, by pixel, for the block boundary image 103 and the singular-point-eliminated image 234. In this manner, a

BE controlled image 235 in FIG. 7(c) is obtained, and each pixel value in the BE controlled image 235 is a block edge signal (hereinafter. referred to as BE signal) 203. Accordingly, the BE signal 203 is on a block boundary and includes information telling that the block noise level is high.

[0116] As is known from the above, compared with the block noise detecting apparatus of the first embodiment, the block noise detecting apparatus 20 according to the second embodiment of the present invention can further classify a block boundary (block boundary image 103) by referring to the extent of image variation of images having block noise. As a result, it is possible to detect only parts having high block noise observed in visual scenes as the block boundary.

(Third Embodiment)

[0117] FIG. 8 is a block diagram showing the structure of a block noise eliminating apparatus according to a third embodiment of the present invention. In FIG. 8, a block noise eliminating apparatus 30 of the third embodiment is structured by a format identifying circuit 31, the block noise detecting apparatus 20, and a block noise eliminating circuit 32.

[0118] The block noise detecting apparatus 20 in the block noise eliminating apparatus 30 of the third embodiment is identical to the block noise detecting apparatus 20 of the second embodiment. Therefore, components therein are provided with the same reference numerals and are not described again.

[0119] FIG. 9 is a block diagram exemplarily showing the structure of the format identifying circuit 31 in FIG. 8. In FIG. 9, the format identifying circuit 31 includes an upconverted H pulse generating part 311 and a bit counter 312.

[0120] FIG. 10 is a block diagram exemplarily showing the structure of the block noise eliminating circuit 32 in FIG. 8. In FIG. 10, the block noise eliminating circuit 32 includes a smoothing processing part 321 and a selector 322.

[0121] FIG. 11 is a diagram exemplarily illustrating smoothing processing carried out by the block noise eliminating circuit 32 in FIG. 8. Note that, FIG. 11(a) shows a state before smoothing (eliminate block noise) and FIG. 11(b) shows a state after smoothing.

[0122] Hereinafter, by referring to FIG. 8 to FIG. 11, it is described stepwise how the block noise eliminating apparatus 30 according to the third embodiment of the present invention is operated.

[0123] The block noise detecting apparatus 20 outputs the BE signal 203 from the received video signal 101 as described above. Herein, a luminance signal (Y signal) is most preferable for the video signal 101 to be inputted into the block noise detecting apparatus 20. The Y signal can be obtained by converting a decode video signal structured by red, green and blue (RGB) into a YUV signal structured by luminance and color-difference by using a matrix circuit, and then extracting only the Y signal therefrom (a well-known technique).

[0124] Referring to FIG. 9, the format identifying circuit 31 receives synchronizing pulses in the horizontal direction (hereinafter, referred to as H pulse) 301 and synchronizing pulses in the vertical direction (hereinafter, referred to as V pulse) 302 from a television signal. The upconverted H pulse generating part 311 receives the H pulse 301, and then generates an upconverted H pulse whose frequency is twice as high as that of the H pulse 301. The bit counter 312 receives the upconverted H pulse outputted from the upconverted H pulse generating part 311 and the V pulse 302, and then counts the number of times the upconverted H pulse is generated by using the V pulse 302 as a reset signal. In detail, the bit counter 312 counts the upconverted H pulse at intervals (V period) of generation of the V pulse 302. The bit counter 312 outputs the least significant bit of values counted in every V period to the block noise detecting apparatus 20 as the format identifying signal 102.

[0125] The reason why the format identifying signal 102 can be generated in such manner is as follows.

[0126] In the interlace system, generally, the number of lines in the V period is 262.5. Accordingly, in the case with the interlace system, the bit counter 312 counts 525 times, twice as much as the number of lines, by using the upconverted H pulse. In the progressive system, on the other hand, the number of lines in the V period is 262 or 263. Accordingly, in the case with the progressive system, the bit counter 312 counts 524 times or 526 times, twice as much as the number of lines, by using the upconverted H pulse. Therefore, by judging whether or not the least significant bit of the values counted in every V period is an even number or an odd number, it is known that the odd number (that is, "5") refers to the interlace system and the even number (that is, "4" or "6") refers to the progressive system.

[0127] In more detail, the format identifying signal 102 outputted from the bit counter 50 is outputted in a form of a binary signal indicating the logical value of "1" (interlace system) and the logical value of "0" (progressive system).

[0128] Referring to FIG. 10, the block noise eliminating circuit 32 receives the video signal 101 and the BE signal 203 outputted from the block noise detecting apparatus 20. The smoothing processing part 321 receives the video signal 101 and smoothes the signal. The selector 322 receives the smoothed video signal outputted from the smoothing processing part 321, the video signal 101 without being smoothed, and the BE signal 203. Then, the selector 322 selects the smoothed signal as to a pixel in which the BE signal 203 has the logical value of "1" (block noise observed), and selects the not-smoothed video signal 101 as to a pixel in which the BE signal 203 has the logical value of "0" (block noise not observed). As is known from this, by using the BE signal 203, the block noise eliminating circuit 32 of

the present invention executes such smoothing that reduces the block noise but blurs edges of the video signal at the same time only on the block boundary where the block noise is observed.

[0129] The signal selected and outputted by the selector 322 is outputted as a block noise eliminating signal 303.

[0130] FIG. 11 exemplarily shows smoothing executed by the smoothing processing part 321. In FIG. 11, smoothing is executed by using a low-pass filter (hereinafter, referred to as LPF) having "3" taps and each weighs 1/3. 1/3, and 1/3.

[0131] In FIG. 11(a), to smooth the block boundary where the BE signal has the logical value of "1", a pixel **a** on the right end of a block **A** and a pixel **b** on the left end in a block **B** adjoining to the block **A** are extracted and smoothed. As a result, as shown in FIG. 11(b), a difference in pixel level around the block boundary can be eliminated. To enhance the effects of the smoothing, the number of pixels to be extracted in the smoothing processing part 321 is set to 2 or more, or the number of taps of the LPF is increased, whereby the smoothing can be more effective.

[0132] When the block noise eliminating signal 303 outputted from the selector 322 is a Y signal, the Y signal can be converted back to an RGB signal by using an inverse matrix circuit with the aforementioned UV signal converted by the matrix circuit. In this manner, a block-noise-eliminated output video signal can be obtained (this is a known technique).

[0133] As is known from the above, the block noise eliminating apparatus 30 according to the third embodiment of the present invention can be best matching to visual scenes and effectively eliminate block noise therein by using the BE signal 203 detected in the second embodiment.

[0134] Note that, in the third embodiment, the block noise detecting apparatus 20 of the second embodiment is used as a block noise detecting apparatus constituting the block noise eliminating apparatus 30. It is possible to use the block noise detecting apparatus 10 of the first embodiment as an alternative thereto.

(Fourth Embodiment)

[0135] FIG. 12 is a block diagram showing the structure of a block noise eliminating apparatus according to a fourth embodiment of the present invention. In FIG. 12, a block noise eliminating apparatus 40 of the fourth embodiment is structured by a horizontal block boundary detecting part 41, a vertical block boundary detecting part 42, a block area detecting part 43, a block boundary smoothing part 44, and a picture enhancing part 45.

[0136] FIG. 13 is a block diagram showing the more detailed structure of the horizontal block boundary detecting part 41 in FIG. 12. In FIG. 13, the horizontal block boundary detecting part 41 is structured by a horizontal HPF 411, an absolute value taking part 412, a vertical accumulating/adding part 413, a high-pass filter (hereinafter, referred to as HPF) 414, a temporal filter 415, an N-point accumulating/adding part 416, a masking part 417, and a maximum value detecting part 418.

[0137] FIG. 14 is a block diagram showing the more detailed structure of the vertical block boundary detecting part 42 in FIG. 12. In FIG. 14, the vertical block boundary detecting part 42 is structured by a vertical HPF 421, an absolute value taking part 422, a horizontal accumulating/adding part 423, an HPF 424, a temporal filter 425, an N-point accumulating/adding part 426, a masking part 427, and a maximum value detecting part 428.

[0138] FIG. 15 is a block diagram showing the more detailed structure of the block boundary smoothing part 44 in FIG. 12. In FIG. 15, the block boundary smoothing part 44 is structured by a horizontal HPF 441, a vertical HPF 442, multiplying parts 443 and 444, and deducting parts 445 and 446.

[0139] FIG. 16 is a block diagram showing the more detailed structure of the picture enhancing part 45 in FIG. 12. In FIG. 16, the picture enhancing part 45 is structured by a horizontal HPF 451, a vertical HPF 452, deducting parts 453 and 454, multiplying parts 455 and 456, and adding parts 457 and 458.

[0140] Hereinafter, by referring to FIG. 12 to FIG. 16, it is described stepwise how the block noise eliminating apparatus 40 according to the fourth embodiment of the present invention is operated.

[0141] The horizontal block boundary detecting part 41 detects a block noise level and a block boundary in the horizontal direction.

[0142] In FIG. 13, the horizontal HPF 411 receives the video signal 101, and then extracts only high frequency components in the horizontal direction. The absolute value taking part 412 receives a signal outputted from the horizontal HPF 411, and takes an absolute value thereof so as to change the value to a positive value. The vertical accumulating/adding part 413 receives a signal outputted from the absolute value taking part 412, and performs accumulation/addition so as to output the horizontal one-dimensional signal 115 having a peak value at horizontal intervals (see FIG. 2). The HPF 414 again extracts high frequency components for the purpose of improving accuracy of the signal outputted from the vertical accumulating/adding part 413, and then detects a horizontal block noise level. The temporal filter 415 extends the horizontal block noise level outputted from the HPF 414 in the temporal direction. The N-point accumulating/adding part 416 accumulates/adds and outputs noise observed in every predetermined N-point (where N indicates the number of pixels in a block), that is, noise observed at the same pixel position in each block. The maximum value detecting part 418 determines a maximum value of the N-point and a block boundary in the horizontal direction. Herein, in a case where the block noise arises at 8 (pix-

els) × 8 (lines) intervals in MPEG2, the maximum value detecting part 418 sets N of the N-point accumulating/adding part 416 to "8", and determines the horizontal block boundary. The masking part 417 masks the horizontal block noise level outputted from the temporal filter 415 on the horizontal boundaries determined by the maximum value detecting part 418, and then outputs only the horizontal block noise level observed on the horizontal block boundary.

[0143] Note that, to detect the horizontal block noise in a much accurate manner, a coring device passing only signals with small amplitude may be inserted into an output signal path of the horizontal HPF 411 or the absolute value taking part 412.

[0144] The vertical block boundary detecting part 42 detects a block noise level and block boundary in the vertical direction in a similar manner to the horizontal block boundary detecting part 41.

[0145] In FIG. 14, the horizontal HPF 421 receives the video signal 101, and extracts only high frequency components in the vertical direction. The absolute value taking part 422 receives a signal outputted from the vertical HPF 421, and takes an absolute value thereof so as to change the value to a positive value. The horizontal accumulating/adding part 423 receives a signal outputted from the absolute value taking part 422, and performs accumulation/addition so as to output the vertical one-dimensional signal 116 having a peak value at vertical intervals (see FIG. 2). The HPF 424 again extracts high frequency components for the purpose of improving accuracy of the signal outputted from the horizontal accumulating/adding part 423, and then detects a vertical block noise level. The temporal filter 425 extends the vertical block noise level outputted from the HPF 424 in the temporal direction. The N-point accumulating/adding part 426 accumulates/adds and outputs noise observed in every predetermined N-point. Accumulates/adds. The maximum value detecting part 428 determines a maximum value of the N-point and block boundary in the vertical direction. Herein, in a case where the block noise arises at 8 × 8 intervals in MPEG2, for example, the maximum value detecting part 428 sets N of the N-point accumulating/adding part 426 to "8", and determines the vertical block boundary. The masking part 427 masks the vertical block noise level outputted from the temporal filter 425 on the vertical block boundary determined by the maximum value detecting part 428, and then outputs only the vertical block noise level observed on the vertical block boundary.

[0146] Note that, as is done in the foregoing, a coring device passing only signals small in amplitude may be inserted into an output signal path of the vertical HPF 421 or the absolute value taking part 422 to detect the vertical block noise in a much accurate manner.

[0147] The block area detecting part 43 detects where the block noise is arisen in which level from each signal on the block noise levels in the vertical and horizontal directions, the N-point block noise level, and the block boundary outputted from the horizontal block boundary detecting part 41 and the vertical block boundary detecting part 42.

[0148] The block boundary smoothing part 44 smoothes the video signal according to the block noise level signals in the vertical/horizontal directions outputted from the block area detecting part 43.

[0149] Referring to FIG. 15, the block boundary smoothing part 44 extracts high frequency components in the horizontal direction from the received video signal 101 by using the horizontal HPF 441. Thereafter, the block boundary smoothing part 44 multiplies the extracted horizontal high frequency components and the horizontal block noise level in the multiplying part 443, and then deducts that from the video signal 101 in the deducting part 445. The same processing is executed also to the vertical direction, and the block boundary smoothing part 44 extracts high frequency components in the vertical direction from the received video signal 101 by using the vertical HPF 442. The block boundary smoothing part 44 multiplies the extracted vertical high frequency components and the vertical block noise level in the multiplying part 444, and then deducts that from the video signal 101 in the deducting part 446.

[0150] In this manner, the larger the block noise levels in the horizontal/vertical directions, the greater extent the video signal 101 is smoothed.

[0151] The picture enhancing part 45 changes a gain/coring volume for picture enhancement, for example, in accordance with the block noise level signals in the horizontal/vertical directions outputted from the block area detecting part 43.

[0152] Referring to FIG. 16, the picture enhancing part 45 extracts high frequency components in the horizontal direction from the received video signal 101 by using the horizontal HPF 451. Thereafter, the picture enhancing part 45 deducts the horizontal block noise level from the set value for the horizontal picture enhancement in the deducting part 453, multiplies the extracted horizontal high frequency components and the horizontal block noise level in the multiplying part 455, and then adds that to the video signal 101 in the adding part 457. The same processing is also executed to the vertical direction, and the picture enhancing part 45 extracts high frequency components in the vertical direction from the received input signal 101 by using the vertical HPF 452. Thereafter, the picture enhancing part 45 deducts the vertical block noise level from the set value for the vertical picture enhancement in the deducting part 454, multiplies the extracted horizontal high frequency components and the horizontal block noise level in the multiplying part 456, and then adds that to the video signal 101 in the adding part 458.

[0153] In this manner, the larger the block noise levels in the horizontal/vertical directions, the greater extent the gain of the horizontal/vertical picture

enhancement is reduced with respect to the video signal 101, thereby allowing the picture enhancement to be done without emphasizing the block noise.

[0154] Typically, a CPU (central processing unit) controls the block noise eliminating apparatus 40 according to the fourth embodiment of the present invention over operation. If this is the case, the CPU may receive output results of the N-point accumulating/adding parts 416 and 426, detect where the block boundary is, and then control the masking parts 417 and 427. Further, the CPU may receive the detected block noise level and the block boundary, and instruct and control picture enhancement level or noise elimination level on a screen. Still further, after the block noise is detected, a judgement result made on types of input sources such as "DVD/DVC/digital" or quality of video signal (MPEG, for example) can be on-screen-displayed (hereinafter, referred to as OSD).

[0155] As is known from this, the block noise eliminating apparatus 40 according to the fourth embodiment of the present invention can accurately detect the block boundary and block noise level. As a result, smoothing or picture enhancement can be properly done corresponding to the block noise level, and accordingly the block noise can be eliminated more effectively for the best match to visual scenes. Further, by OSD displaying information, video sources or effects of block noise elimination can be acknowledged at a glance.

(Fifth Embodiment)

[0156] When the block noise eliminating apparatus of the fourth embodiment is presumably provided for a television system, for example, the video signal 101 to be inputted may include a video signal in a different signal form being inputted from an external terminal in addition to a normal television video signal.

[0157] Therefore, a fifth embodiment is to provide a block noise eliminating apparatus corresponding to input video signals in various signal forms.

[0158] FIG. 17 is a block diagram showing the structure of a block noise eliminating apparatus according to a fifth embodiment of the present invention. In FIG. 17, a block noise eliminating apparatus 50 of the fifth embodiment is structured by an AD converter 51, a digital decoding part 52, a selector 53, a horizontal block boundary detecting part 54, a vertical block boundary detecting part 55, the block area detecting part 43, the block boundary smoothing part 44, and the picture enhancing part 45.

[0159] FIG. 18 is a block diagram showing the more detailed structure of the horizontal block boundary detecting part 54 in FIG. 17. In Fig. 18, the horizontal block boundary detecting part 54 is structured by the horizontal HPF 411, the absolute value taking part 412, the vertical accumulating/adding part 413, the HPF 414, the temporal filter 415, the N-point accumulating/adding part 416, the masking part 417, the maximum value detecting part 418, and a selector 541.

[0160] FIG. 19 is a block diagram showing the more detailed structure of the vertical block boundary detecting part 55 in FIG, 17. In FIG. 19, the vertical block boundary detecting part 55 is structured by the vertical HPF 421, the absolute value taking part 422, the horizontal accumulating/adding part 423, the HPF 424, the temporal filter 425, the N-point accumulating/adding part 426, the masking part 427, the maximum value detecting part 428, and a selector 551.

[0161] Herein, the block noise eliminating apparatus 50 of the fifth embodiment and the block noise eliminating apparatus 40 of the fourth embodiment are identical in the block area detecting part 43, the block boundary smoothing part 44, and the picture enhancing part 45. Therefore, those components are provided with the same reference numerals and not described again.

[0162] The horizontal block boundary detecting part 54 is identical to the horizontal block boundary detecting part 41 described in the fourth embodiment but additionally has the selector 541 therein, and the vertical block boundary detecting part 55 is identical to the vertical block boundary detecting part 42 described in the fourth embodiment but additionally has the selector 551. Therefore, the same components are under identical reference numerals and are not described again.

[0163] Hereinafter, referring to FIG. 17 to FIG. 19, it is described stepwise how the block noise eliminating apparatus 50 according to the fifth embodiment of the present invention is operated.

[0164] The AD converter 51 receives an analog video signal 501. The digital decoding part 52 receives, a digital video signal 502 in an MPEG stream or DV format to be connected according to IEEE 1394 standards, for example. The AD converter 51 A/D converts the received analog video signal 501, and outputs the same to the selector 53. The digital decoding part 52 decodes the received digital video signal 502 and outputs the same to the selector 53. The digital decoding part 52 can output block information signals 521 and 522 (that is, block boundary) indicating a block size where the video signal 502 is decoded.

[0165] The selector 53 selects either one of the inputted two digital video signals as instructed by a user, and then outputs the same as the video signal 101. Herein, the selector 53 outputs a receiving pulse 531 indicating which digital video signal is selected and outputted. When an output of the AD converter 51 is selected (input is presumably a DVD analog signal), the logical value of "0" is outputted as the receiving pulse 531, and when an output of the digital decoding part 52 is selected (input is presumably a digital signal of a digital video camera (DVD)), the logical value of "1" is outputted. The receiving pulse 531 can, for example, be utilized as information for OSD indicating what was received. In the above example, characters such as "DVD" or "DVC" can be OSD on a television screen.

[0166] The video signal 101 selected in the selector 53 and the block information signals 521 and 522 outputted from the digital decoding part 52 are to be inputted into the horizontal block boundary detecting part 54 and the vertical block boundary detecting part 55.

[0167] The horizontal block boundary detecting part 54 detects the block noise level and block boundary in the horizontal direction as is described in the foregoing as a matter of principle. The maximum value detecting part 418 outputs the determined horizontal block boundary to the selector 541. The selector 541 receives the horizontal block boundary outputted from the maximum value detecting part 418 and the block information signal 521 outputted from the digital decoding part 52. Thereafter, the selector 541 selects and outputs, as is instructed by the user (synchronizes with the user's instruction to the selector 53), the horizontal block boundary determined by the maximum value detecting device 418 when the selector 53 selected the output signal of the AD converter 51, and selects and outputs the horizontal block boundary provided as the block information signal 521 when the selector 53 selected the output signal of the digital decoding part 52.

[0168] In a similar manner, the vertical block boundary detecting part 55 detects the block noise level and the block boundary in the vertical direction, as is described in the foregoing as a matter of principle, while the maximum value detecting part 428 outputs the determined vertical block boundary to the selector 551. The selector 551 receives the vertical block boundary outputted from the maximum value detecting part 428 and the block information signal 522 outputted from the digital decoding part 52. Thereafter, as is instructed by the user (synchronizes with the user's instruction to the selector 53), the selector 551 selects and outputs the vertical block boundary determined by the maximum value detecting device 428 when the selector 53 selected an output signal of the AD converter 51, and selects and outputs the vertical block boundary provided as the block information signal 522 when the selector 53 selects the output signal of the digital decoding part 52.

[0169] In this manner, when the analog video signal 501 whose block boundary is not clearly identified is inputted, the block boundary determined by the horizontal block boundary detecting part 54 and the vertical block boundary detecting part 55 are used to eliminate the block noise, and when the digital video signal 502 whose block boundary can be identified (provided) is inputted, the block boundary is used to eliminate the block noise.

[0170] As is clear from the above, the block noise eliminating apparatus 50 according to the fifth embodiment of the present invention can correctly detect the block boundary and block noise level corresponding to the to-receive video signal. As a result, smoothing or picture enhancement can be properly done corresponding to the block noise level, and accordingly the block noise can be eliminated more effectively for the best match to visual scenes. Further, by OSD displaying information, video sources or effects of block noise elimination can be acknowledged at a glance.

(Sixth Embodiment)

[0171] Other than the block noise, a dot clock not properly regenerated may degrade a video signal in image quality. The dot clock not properly regenerated is caused, at the time of A/D conversion for the video signal, by a phase shift between a clock phase sampled by an analog video signal and a clock phase sampled by a digital-converted video signal as is well known.

[0172] Therefore, a sixth embodiment of the present invention is to correctly regenerate the dot clock by applying the aforementioned technique for detecting the block boundary.

[0173] FIG. 20 is a block diagram exemplarily showing the structure of a video processing system using a block detecting apparatus according to a sixth embodiment of the present invention. In FIG. 20, a video processing system 60 using the block detecting apparatus of the sixth embodiment is structured by an AD converter 61, a video signal processing device 62, a DA converter 63, a horizontal block boundary detecting part 64, a clock generating device 65, and a controlling part 66. The clock generating device 65 is structured by a phase comparator 651, an LPF 652, a VCO 653, a variable delay 654, and a frequency divider 655.

[0174] FIG. 21 is a block diagram showing the more detailed structure of the horizontal block boundary detecting part 64 in FIG. 20. In FIG. 21, the horizontal block boundary detecting part 64 is structured by a horizontal HPF 641, an absolute value taking part 642, a vertical accumulating/adding part 643, an HPF 644, and an N-point accumulating/adding part 645.

[0175] FIG. 22 is a diagram exemplarily showing an accumulation/addition result of the horizontal block noise outputted from the horizontal block boundary detecting part 64 in FIG. 20. Note that, the accumulation/addition result shown in FIG. 22 is obtained when N being "8".

[0176] FIG. 23 is a diagram illustrating how a video signal 601 and a clock (CK) are related to each other.

[0177] Hereinafter, by referring to FIG. 20 to FIG. 23, it is described stepwise how the video processing system 60 using the block detecting apparatus according to the sixth embodiment of the present invention is operated.

[0178] First of all, components in the video processing system 60 of the sixth embodiment are each described.

[0179] The AD converter 61 converts the received analog video signal 601 into a digital video signal. The video signal processing device 62 executes various types of processing relevant to the video signal such as picture enhancement. The DA converter 63 converts the

digital video signal into the analog video signal. The horizontal block boundary detecting part 64 detects the block boundary in the horizontal direction from the received digital video signal. The clock generating device 65 structures a PLL circuit of a line clock, and generates a regeneration clock (CK) used for each component to process. Herein, as components of the clock regenerating device 65 are conventionally all known, further description is not made. The controlling part 66 includes a control device such as CPU or for temporally filtering output signals of the horizontal block boundary detecting part 64, and controls the clock generating device 65 in accordance with the signal outputted from the horizontal block boundary detecting part 64.

[0180] Next, it is described how the video processing system 60 of the sixth embodiment is operated to process.

[0181] The video signal 601 inputted into the AD converter 61 is converted into a digital video signal according to the regeneration clock (CK) generated in the clock regenerating device 65. The converted digital signal is subjected to a desired video signal processing in the video signal processing device 62, and is converted into an analog video signal in the DA converter 63. Further, the converted digital video signal is inputted into the horizontal block boundary detecting means 64, and then is subjected to accumulation/addition of the horizontal block noise so as to be transmitted to the controlling part 66.

[0182] In the horizontal block boundary detecting part 64, the horizontal HPF 641 receives the video signal 601, and then extracts only high frequency components in the horizontal direction. The absolute value taking part 642 receives a signal outputted from the horizontal HPF 641, and takes an absolute value thereof so as to change the same to a positive value. The vertical accumulating/adding part 643 receives a signal outputted from the absolute value taking part 642, and performs accumulation/addition so as to output the horizontal one-dimensional signal 115 having a peak value at intervals in the horizontal direction (see FIG. 2). The HPF 644 again extracts high frequency components for the purpose of improving accuracy of the signal outputted from the vertical accumulating/adding part 643, and detects a horizontal block noise level. The N-point accumulating/adding part 645 accumulates/adds and outputs noise observed in every predetermined N-point (where N indicates the number of pixels in a block), that is, noise observed at the same pixel position in each block. Herein, in a case where the block noise arises at 8 (pixels) × 8 (lines) intervals in MPEG2, for example, the N-point accumulating/adding part 645 sets N to "8", and determines the horizontal block boundary so as to output the same to the controlling part 66.

[0183] Note that, to detect the horizontal block noise in a much accurate manner, a coring device passing only signals of small amplitude may be inserted into an output signal path of the horizontal HPF 641 or the absolute value taking part 642.

[0184] Next, by referring to FIG. 22 and FIG. 23, it is described how the dot clock control is done.

[0185] First, in a case where the dot clock is not properly regenerated (that is, when the dot clock of the original video signal 601 and regeneration clock (CK) are not coincided), a phase of the sampling clock may shift (FIG. 23(b)) with respect to the video signal (FIG. 23(a)). If this is the case, an accumulation/addition result of the N-point outputted by the N-point accumulating/adding part 645 to the controlling part 66 will be high in level at a plurality of points as shown in FIG. 22(a) (in the drawing, two points of 4 and 5).

[0186] On the other hand, in a case where the dot clock is well regenerated (that is, when the dot clock of the original video signal 601 and the regeneration clock (CK) are coincided), the phase of the sampling clock does not shift (FIG. 23(c)) with respect to the video signal (FIG. 23(a)). If this is the case, the accumulation/addition result of the N-point outputted from the N-point accumulating/adding part 645 to the controlling part 66 will be high in level only at a point as shown in FIG. 22(b) (in the drawing, a position of 5).

[0187] As is known from this, the controlling part 66 executes a feedback control of changing delay of a variable delay 645 in the clock regeneration device 65 in such a manner as to set the accumulation/addition result of the N-point outputted from the N-point accumulating/adding part 645 to be high in level at only one position. Therefore, it becomes possible to correctly regenerate the clock phase sampled by the to-receive video signal 601 in the video processing system 60.

[0188] As is clear from the foregoing, the video processing system 60 using the block detecting apparatus according to the sixth embodiment of the present invention detects horizontal block boundary corresponding to a to-receive video signal, and then regenerates a dot clock in accordance with positions thereof. In this manner, a clock whose phase is coincided with that of a dot clock of an original video signal can correctly be regenerated.

[0189] Note that, in a typical hardware environment, each function realized by the block noise detecting apparatus 10, 20, the block noise eliminating apparatus 30, 40, and 50, and the video processing system 60 according to the aforementioned first to sixth embodiments can be realized by a memory device in which predetermined program data is stored (ROM, RAM, hard disk, for example) and a CPU which runs the program data. In such case, the respective program data can be introduced via a recording medium such as CD-ROM or floppy disk.

INDUSTRIAL APPLICABILITY

[0190] As is described in the foregoing, in a video processing device (a television receiver, for example) using digital video signals subjected to lossy encoding

on a predetermined image block basis, the present invention can be applied, first, to correctly detect and eliminate block noise to be arisen when the video signal is decoded, and second, to correctly regenerate a dot clock.

Claims

1. A block noise detecting apparatus of a type detecting, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise caused by decoding the video signal, the apparatus comprising:

    means for detecting a level of said block noise in said video signal; and
    means for detecting a block boundary (where said block noise is generated) in said video signal.

2. A block noise detecting apparatus of a type detecting, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise caused by decoding the video signal, the apparatus comprising:

    signal extracting means for receiving said video signal and extracting only a high frequency component therefrom;
    absolute value taking means for taking an absolute value of a high frequency component signal outputted from said signal extracting means;
    accumulating/adding means for accumulating/adding said absolute-value-taken high frequency component signal outputted from said absolute value taking means in a predetermined period;
    periodicity detecting means for detecting periodicity of said block noise in accordance with an accumulation/addition result outputted from said accumulating/adding means; and
    block boundary determining means for determining a block boundary (where said block noise is generated) from a periodic signal detected by said periodicity detecting means.

3. The block noise detecting apparatus according to claim 2, wherein said block boundary determining means distinguishes, in binary, between positional information on said block boundary and positional information on the rest.

4. The block noise detecting apparatus according to claim 2 or claim 3, further comprising:

    frame difference taking means for receiving said video signal and determining a signal difference among a plurality of predetermined frames thereof;
    region determining means for determining, by referring to the signal difference outputted from said frame difference taking means for whether or not the difference is more than a predetermined threshold value, a region where the block noise to be eliminated is observed (hereinafter, referred to as noise region); and
    block edge controlling means for masking said block boundary determined by said block boundary determining means in said noise region determined by said region determining means, and then determining a block boundary corresponding to the noise region.

5. The block noise detecting apparatus according to claim 4, wherein said frame difference taking means determines a signal difference between a current frame and a one-frame-before frame.

6. The block noise detecting apparatus according to claim 4 or claim 5, wherein said region determining means distinguishes, in binary, between a part exceeding said threshold value and a part not exceeding said threshold value.

7. The block noise detecting apparatus according to any one of claims 4 to 6, further comprising singular point eliminating means for excluding a noise part observed in a predetermined small region of said noise region determined by said region determining means, wherein

    said block edge controlling means masks the block boundary determined by said block boundary determining means in said noise-part-excluded noise region outputted from said singular point eliminating means.

8. The block noise detecting apparatus according to any one of claims 2 to 7, wherein said signal extracting means, said absolute value taking means, said accumulating/adding means, and said periodicity detecting means each execute processing for said video signal in either horizontal or vertical direction, or both directions.

9. The block noise detecting apparatus according to claim 8, wherein,

    when each of the processing is executed for said video signal in the vertical direction,
    said periodicity detecting means successively changes frames used for detection according to a format of said video signal to be inputted.

10. A block noise eliminating apparatus of a type

detecting and eliminating, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise caused by decoding the video signal, the apparatus comprising:

means for detecting a level of said block noise in said video signal;
means for detecting a block boundary (where said block noise is generated) in said video signal; and
means for eliminating, in said block boundary, only said block noise whose said detected level is more than a predetermined threshold value.

11. A block noise eliminating apparatus of a type detecting and eliminating, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise caused by decoding the video signal, the apparatus comprising:

signal extracting means for receiving said video signal and extracting only a high frequency component therefrom;
absolute value taking means for taking an absolute value of a high frequency component signal outputted from said signal extracting means;
accumulating/adding means for accumulating/adding said absolute-value-taken high frequency component signal outputted from said absolute value taking means in a predetermined period;
periodicity detecting means for detecting periodicity of said block noise in accordance with an accumulation/addition result outputted from said accumulating/adding means;
block boundary determining means for determining a block boundary (where said block noise is generated) from a periodic signal detected by said periodicity detecting means; and
block noise eliminating means for eliminating said block noise with respect to said block boundary.

12. The block noise eliminating apparatus according to claim 11, wherein said block boundary determining means distinguishes, in binary, between positional information on said block boundary and positional information on the rest.

13. The block noise eliminating apparatus according to claim 11 or claim 12, further comprising:

frame difference taking means for receiving said video signal and determining a signal difference among a plurality of predetermined frames thereof;
region determining means for determining, by referring to the signal difference outputted from said frame difference taking means for whether or not the difference is more than a predetermined threshold value, a region where the block noise to be eliminated is observed (hereinafter, referred to as noise region); and
block edge controlling means for masking said block boundary determined by said block boundary determining means in said noise region determined by said region determining means, and then determining a block boundary corresponding to the noise region, wherein
said block noise eliminating means eliminates said block noise with respect to the block boundary corresponding to said noise region.

14. The block noise eliminating apparatus according to claim 13, wherein said frame difference taking means determines a signal difference between a current frame and a one-frame-before frame.

15. The block noise eliminating apparatus according to claim 13 or claim 14, wherein said region determining means distinguishes, in binary, between a part exceeding said threshold value and a part not exceeding said threshold value.

16. The block noise eliminating means according to any one of claims 13 to 15, further comprising singular point eliminating means for excluding a noise part observed in a predetermined small region of said noise region determined by said region determining means, wherein

said block edge controlling means masks the block boundary determined by said block boundary determining means in said noise-part-excluded noise region outputted from said singular point eliminating means.

17. The block noise eliminating apparatus according to any one of claims 11 to 16, wherein said signal extracting means, said absolute value taking part, said accumulating/adding means, and said periodicity detecting means each execute processing for said video signal in either horizontal or vertical direction, or both directions.

18. The block noise eliminating apparatus according to claim 17, further comprising identifying means for identifying a format for said video signal to be inputted, wherein

when each of the processing is executed for said video signal in the vertical direction,
said identifying means has said periodicity detecting means successively change frames

used for detection according to said format.

19. A block noise eliminating apparatus of a type detecting and eliminating, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise caused by decoding the video signal, the apparatus comprising:

vertical block boundary detecting means for receiving said video signal and detecting, with respect to the video signal, a block boundary (where said block noise is generated) in the lateral direction and a block noise level on a screen;
horizontal block boundary detecting means for receiving said video signal and detecting, with respect to the video signal, said block boundary in a longitudinal direction and block noise level on the screen;
black area detecting means for specifying said block boundary in both longitudinal and lateral directions from detection results of said vertical block boundary detecting means and said horizontal block boundary detecting means; and
block boundary smoothing means for smoothing said video signal to be inputted in a predetermined manner corresponding to said block boundary in both longitudinal and lateral directions specified by said block area detecting means.

20. The block noise eliminating apparatus according to claim 19, wherein said vertical block boundary detecting means comprises:

a vertical high-pass filter (hereinafter, referred to as HPF) extracting only a vertical high frequency component of said video signal;
first absolute value taking means for taking an absolute value of a high frequency component signal outputted from said vertical HPF;
horizontal accumulating/adding means for accumulating/adding said absolute-value-taken high frequency component signal outputted from said first absolute value taking means in the horizontal direction;
a first HPF again extracting high frequency component from said accumulated/added high frequency component signal outputted from said horizontal accumulating/adding means;
first N-point accumulating/adding means for accumulating/adding a signal outputted from said first HPF on a predetermined N-point basis (where N is a positive integer);
a first temporal filter detecting said block noise level of said video signal by computing a signal outputted from said first HPF in the temporal direction;
first maximum value detecting means for determining a maximum value and a position thereof among N-piece accumulated/added values determined by said first N-point accumulating/adding means through accumulation/addition; and
first masking means for masking said block noise level detected by said first temporal filter at said position of the maximum value outputted from said first maximum value detecting means, and then determining a vertical block boundary corresponding to the position, wherein

said horizontal block boundary detecting means comprises:

a horizontal HPF extracting only a horizontal high frequency component of said video signal;
second absolute value taking means for taking an absolute value of a high frequency component signal outputted from said horizontal HPF;
vertical accumulating/adding means for accumulating/adding said absolute-value-taken high frequency component signal outputted from said second absolute value taking means in the vertical direction;
a second HPF again extracting high frequency component from the accumulated/added high frequency component signal outputted from said vertical accumulating/adding means;
N-point accumulating/adding means for accumulating/adding a signal outputted from said second HPF on a predetermined N-point basis;
a second temporal filter detecting said block noise level of said video signal by computing the signal outputted from said second HPF in the temporal direction;
second maximum value detecting means for determining a maximum value and a position thereof among the N-piece accumulated/added values determined by said second N-point accumulating/adding means through accumulation/addition; and
second masking means for masking said block noise level detected by said second temporal filter at said position of the maximum value outputted from said second maximum value detecting means, and then determining a vertical block boundary corresponding to the position.

21. A block noise eliminating apparatus of a type detecting and eliminating, from a video signal subjected to lossy encoding on a predetermined image block basis, block noise caused by decoding the video signal, the apparatus comprising:

AD converting means for receiving said video signal in an analog fashion and then converting the same into a digital fashion;

digital decoding means for receiving said video signal in an encoded digital fashion for decoding and outputting the decoded block boundary information;

a selector receiving the video signal outputted from said AD converting means and the video signal outputted from said digital decoding means and selectively outputting either one of the video signals as is externally instructed;

vertical block boundary detecting means for receiving the video signal selected by said selector and detecting, with respect to the video signal, a block boundary (where said block noise is generated) in the lateral direction and a block noise level on a screen;

horizontal block boundary detecting means for receiving the video signal selected by said selector and detecting, with respect to the video signal, said block boundary in the longitudinal direction and the block noise level on a screen;

block area detecting means for specifying said block boundary in both longitudinal and lateral directions from detection results of said vertical block boundary detecting means and said horizontal block boundary detecting means; and

block boundary smoothing means for smoothing said video signal to be inputted in a predetermined manner corresponding to said block boundary in both longitudinal and lateral directions specified by said block area detecting means, wherein

said vertical block boundary detecting means and said horizontal block boundary detecting means output, to said block area detecting means, said block boundary based on each of the detection results when said selector selects the video signal outputted from said AD converting means, and output the block boundary based on said block boundary information outputted from said digital decoding means when said selector selects the video signal outputted from said digital decoding means.

22. The block noise eliminating apparatus according to claim 21, wherein said vertical block boundary detecting means comprises:

a vertical high-pass filter (hereinafter, referred to as HPF) extracting only a vertical high frequency component of said video signal;

first absolute value taking means for taking an absolute value of a high frequency component signal outputted from said vertical HPF;

horizontal accumulating/adding means for accumulating/adding said absolute-value-taken high frequency component signal outputted from said first absolute value taking means in the horizontal direction;

a first HPF again extracting high frequency component from said accumulated/added high frequency component signal outputted from said horizontal accumulating/adding means;

first N-point accumulating/adding means for accumulating/adding a signal outputted from said first HPF on a predetermined N-point basis (where N is a positive integer);

a first temporal filter detecting said block noise level of said video signal by computing the signal outputted from said first HPF in the temporal direction;

first maximum value detecting means for determining a maximum value and a position thereof among N-piece accumulated/added values determined by said first N-point accumulating/adding means through accumulation/addition;

a first selector synchronizing with said selector's selection and selectively outputting either one of said block boundary information outputted from said digital decoding means or said position of the maximum value outputted from said first maximum value detecting means; and

first masking means for masking said block noise level detected by said first temporal filter at the block boundary outputted from said first selector, and determining a vertical block boundary corresponding to the position, wherein

said horizontal block boundary detecting means comprises:

a horizontal HPF extracting only a horizontal high frequency component of said video signal;

second absolute value taking means for taking an absolute value of a high frequency component signal outputted from said horizontal HPF;

vertical accumulating/adding means for accumulating/adding said absolute-value-taken high frequency component signal outputted from said second absolute value taking means in the vertical direction;

a second HPF again extracting high frequency component from an accumulated/added high frequency component signal outputted from said vertical accumulating/adding means;

N-point accumulating/adding means for accumulating/adding a signal outputted from said second HPF on a predetermined N-point basis;

a second temporal filter detecting said block noise level of said video signal by computing the signal outputted from said second HPF in

the temporal direction;

second maximum value detecting means for determining a maximum value and a position thereof among the N-piece accumulated/added values determined by said second N-point accumulating/adding means through accumulation/addition;

a second selector synchronizing with said selector's selection and selectively outputting either one of said block boundary information outputted from said digital decoding means or said position of the maximum value outputted from said second maximum value detecting means; and

second masking means for masking said block noise level detected by said second temporal filter at the block boundary outputted from said second selector, and determining a vertical block boundary corresponding to the position.

23. The block noise eliminating apparatus according to claim 20 or 22, wherein said block boundary smoothing means comprises:

a horizontal HPF extracting only a horizontal high frequency component of said video signal;

first multiplying means for multiplying an output of said horizontal HPF and an output of said horizontal block boundary detecting means;

first deducting means for deducting an output of said first multiplying means from said video signal;

a vertical HPF extracting only a vertical high frequency component of said video signal;

second multiplying means for multiplying an output of said vertical HPF and an output of said vertical block boundary detecting means; and

second deducting means for deducting an output of said second multiplying means from said video signal, wherein

said block noise is eliminated according to said block noise level.

24. The block noise eliminating apparatus according to any one of claims 19 to 23, further comprising picture enhancing means for controlling an picture enhancement level emphasizing an outline part of said video signal according to said block noise level detected by said horizontal block boundary detecting means and said vertical block boundary detecting means.

25. The block noise eliminating apparatus according to any one of claims 19 to 24, further comprising controlling means for specifying said video signal (type or quality thereof, for example) to be inputted in accordance with said block noise level detected by said horizontal block boundary detecting means and said vertical block boundary detecting means, and

said controlling means on-screen-displays a result of said specification on a screen in a predetermined format.

26. A vertical block boundary detecting apparatus of a type detecting, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise in the vertical direction caused by decoding the video signal, the apparatus comprising:

a vertical high-pass filter (hereinafter, referred to as HPF) receiving said video signal and extracting only a vertical high frequency component of the video signal;

absolute value taking means for taking an absolute value of a high frequency component signal outputted from said vertical HPF;

horizontal accumulating/adding means for accumulating/adding said absolute-value-taken high frequency component signal outputted from said absolute value taking means in the horizontal direction;

an HPF again extracting high frequency component from said accumulated/added high frequency component signal outputted from said horizontal accumulating/adding means;

N-point accumulating/adding means for accumulating/adding a signal outputted from said HPF on a predetermined N-point basis (where N is a positive integer);

a temporal filter detecting said block noise level of said video signal by computing the signal outputted from said HPF in the temporal direction;

maximum value detecting means for determining a maximum value and a position thereof among N-piece accumulated/added values determined by said N-point accumulating/adding means through accumulation/addition; and

masking means for masking said block noise level detected by said temporal filter at said position of the maximum value outputted from said maximum value detecting means, and determining a vertical block boundary corresponding to the position.

27. A horizontal block boundary detecting apparatus of a type detecting, from a digital video signal subjected to lossy encoding on a predetermined image block basis, block noise in the horizontal direction caused by decoding the video signal, the apparatus comprising:

a horizontal high-pass filter (hereinafter, referred to as HPF) receiving said video signal and extracting only a vertical high frequency component of the video signal;
absolute value taking means for taking an absolute value of a high frequency component signal outputted from said horizontal HPF;
vertical accumulating/adding means for accumulating/adding said absolute-value-taken high frequency component signal outputted from said absolute value taking means in the vertical direction;
an HPF again extracting high frequency component from said accumulated/added high frequency component signal outputted from said vertical accumulating/adding means;
N-point accumulating/adding means for accumulating/adding a signal outputted from said HPF on a predetermined N-point basis (where N is a positive integer);
a temporal filter detecting said block noise level of said video signal by computing the signal outputted from said HPF in the temporal direction;
maximum value detecting means for determining a maximum value and a position thereof among N-piece accumulated/added values determined by said N-point accumulating/adding means through accumulation/addition; and
masking means for masking said block noise level detected by said temporal filter at said position of the maximum value outputted from said maximum value detecting means, and determining a horizontal block boundary corresponding to the position.

28. A dot clock controlling apparatus of a type controlling a dot clock to be regenerated in a video processing system in which a digital video signal subjected to lossy encoding on a predetermined image block basis is processed, the apparatus comprising:

clock generating means for generating said dot clock used in said video processing system in accordance with a horizontal synchronizing pulse;
horizontal block boundary detecting means for receiving said video signal and detecting a longitudinal block boundary (where said block noise is generated) on a screen with respect to the video signal; and
controlling means for changing delay of said clock generating means in such a manner that said block boundary detected by said horizontal block boundary detecting means periodically has a single maximum point (peak).

29. The dot clock controlling apparatus according to claim 28, wherein said horizontal block boundary detecting means comprises:

a horizontal high-pass filter (hereinafter, referred to as HPF) receiving said video signal and extracting only a vertical high frequency component of the video signal;
absolute value taking means for taking an absolute value of a high frequency component signal outputted from said horizontal HPF;

vertical accumulating/adding means for accumulating/adding said absolute-value-taken high frequency component signal outputted from said absolute value taking means in the vertical direction;
an HPF again extracting high frequency component from said accumulated/added high frequency component signal outputted from said vertical accumulating/adding means; and
N-point accumulating/adding means for accumulating/adding a signal outputted from said HPF on a predetermined N-point basis (where N is a positive integer).

30. A recording medium containing a program recorded thereon, to be run in a computer device, for detecting block noise from a digital video signal subjected to lossy encoding on a predetermined image block basis caused by decoding the video signal, the program for realizing an operational environment on said computer device comprising the steps of:

extracting only a high frequency component from said video signal;
taking an absolute value of said extracted high frequency component signal;
accumulating/adding said absolute-value-taken high frequency component signal in a predetermined period;
detecting periodicity of said block noise in accordance with said accumulation/addition result; and
determining a block boundary (where said block noise id generated) in accordance with a signal having said detected periodicity.

31. The recording medium according to claim 30, further comprising a step of eliminating said block noise with respect to said block boundary.

32. The recording medium according to claim 30 or 31, wherein, in said step of determining said block boundary, positional information on said block boundary and positional information on the rest are distinguished, in binary, from each other.

33. The recording medium according to any one of claims 30 to 32, further comprising the steps of:

determining a signal difference among a plurality of predetermined frames of said video signal;
determining a region where block noise to be eliminated is observed (hereinafter, referred to as noise region) with reference to whether or not the signal difference is larger than a predetermined threshold value; and
masking said block boundary in said noise region, and determining a block boundary corresponding to the noise region.

34. The recording medium according to claim 33, wherein, in said step of determining the signal difference, a signal difference between a current frame and a one-before-frame is determined .

35. The recording medium according to claim 33 or 34, wherein, in said step of determining the noise region, a part exceeding said threshold value and a part not exceeding said threshold value are distinguished, in binary, from each other.

36. The recording medium according to any one of claims 33 to 35, further comprising a step of eliminating a noise part in a predetermined small region of said noise region, wherein

in said step of determining a block boundary corresponding to said noise block, said block boundary is masked in said noise-part-eliminated noise region.

37. The recording medium according to any one of claims 30 to 36, wherein each of said steps is executed in either horizontal direction or vertical direction of said video signal, or in both directions.

38. The recording medium according to claim 37, wherein, when each of said processing is executed in the vertical direction of said video signal,

in said step of detecting periodicity, frames used for detection are successively changed corresponding to a format of said video signal to be inputted.

39. A recording medium containing a program recorded thereon, to be run in a computer device, for detecting block noise from a digital video signal subjected to lossy encoding on a predetermined image block basis caused by decoding the video signal, the program for realizing an operational environment on said computer device comprising the steps of:

detecting, with respect to said video signal, a block boundary (where said block boundary is generated) in the lateral direction and a block noise level on the screen;
detecting, with respect to said video signal, said block boundary in the longitudinal direction and block noise level on the screen;
specifying said block boundary in both longitudinal and lateral directions from detection results obtained in said step of detecting as to the lateral direction and said step of detecting as to the longitudinal direction; and
smoothing said video signal in a predetermined manner corresponding to said block boundary in both longitudinal and lateral directions.

40. The recording medium according to claim 39, wherein said step of detecting as to the lateral direction comprises the steps of:

extracting only a vertical high frequency component from said video signal;
taking an absolute value of said extracted high frequency component signal;
accumulating/adding said absolute-value-taken high frequency component signal in the horizontal direction;
again extracting high frequency component from said accumulated /added high frequency component signal;
accumulating/adding a signal outputted in said step of again extracting high frequency component on a predetermined N-point basis (N is a positive integer);
detecting said block noise level of said video signal by computing the signal outputted in said step of again extracting high frequency component in the temporal direction;
determining a maximum value and a position thereof among N-piece accumulated/added values determined by said accumulation/addition; and
masking said detected block noise level at said position of the maximum value, and determining a vertical block boundary corresponding to the position, and

said step of detecting as to said longitudinal direction comprises the steps of:

extracting only a horizontal high frequency component of said video signal;
taking an absolute value of said extracted high frequency component signal;
accumulating/adding said absolute-value-taken high frequency component signal in the vertical direction;
again extracting high frequency component

from said accumulated/added high frequency component signal;

accumulating/adding a signal outputted in said step of again extracting high frequency component on a predetermined N-point basis;

detecting said block noise level of said video signal by computing the signal outputted in said step of again extracting high frequency component in the temporal direction;

determining a maximum value and a position thereof among the N-piece accumulated/added values determined by said accumulation/addition; and

masking said detected block noise level at said position of the maximum value, and determining a vertical block boundary corresponding to the position.

41. A recording medium containing a program recorded thereon, to be run in a computer device, for detecting block noise from a video signal subjected to lossy encoding on a predetermined image block basis caused by decoding the video signal, the program for realizing an operational environment on said computer device further comprising the steps of:

converting said video signal in an analog fashion into a digital fashion;

decoding said digital-encoded video signal;

outputting said decoded block boundary information;

selecting either one of a video signal outputted in said converting step or a video signal outputted in said decoding step as is externally instructed;

detecting a lateral block boundary (where said block noise is generated) on a screen and a block noise level with respect to the video signal outputted in said selecting step;

detecting a longitudinal block boundary on a screen and a block noise level with respect to the video signal outputted in said selecting step;

specifying said block boundary in both longitudinal and lateral directions from detection results obtained in said step of detecting the lateral direction and said step of detecting said longitudinal direction; and

smoothing said video signal in a predetermined manner according to said block boundary in both longitudinal and lateral directions, wherein in said step of detecting as to lateral direction and said step of detecting as to longitudinal direction, said block boundary based on each of the detection results is outputted for the video signal outputted in said converting step, and said block boundary based on said decoded block boundary information are outputted for the video signal outputted in said decoding step.

42. The recording medium according to claim 41, wherein said step of detecting as to said lateral direction comprises the steps of:

extracting only a vertical high frequency component of said video signal;

taking an absolute value of said extracted high frequency component signal;

accumulating/adding said absolute-value-taken high frequency component signal in the horizontal direction ;

again extracting high frequency component from said accumulated /added high frequency component signal;

accumulating/adding a signal outputted in said step of again extracting high frequency component on a predetermined N-point basis (n is a positive integer);

detecting said block noise level of said video signal by computing the signal outputted in said step of again extracting high frequency component in the temporal direction;

determining a maximum value and a position thereof among N-piece accumulated/added values determined by said accumulation/addition; and

synchronizing with said selecting step, and selectively outputting either one of said block boundary information and said maximum value position; and

masking said block noise level at the block boundary outputted in said selectively outputting step, and determining a vertical block boundary corresponding to the position, and

said step of detecting as to longitudinal direction comprises the steps of:

extracting only a horizontal high frequency component of said video signal;

taking an absolute value of said extracted high frequency component signal;

accumulating/adding said absolute-value-taken high frequency component signal in the vertical direction ;

again extracting high frequency component from said accumulated /added high frequency component signal;

accumulating/adding a signal outputted in said step of again extracting high frequency component on a predetermined N-point basis;

detecting said block noise level of said video signal by computing the signal outputted in said step of again extracting high frequency compo-

nent in the temporal direction;

determining a maximum value and a position thereof among the N-piece accumulated/added values determined by said accumulation/addition; and

synchronizing with said selecting step, and selectively outputting either one of said block boundary information or said position of the maximum value; and

masking said block noise level at the block boundary outputted in said selectively outputting step, and determining a horizontal block boundary corresponding to the position.

43. The recording medium according to claim 40 or 42, wherein, in said smoothing step further comprises:

a horizontal step of extracting only a horizontal high frequency component of said video signal;

a horizontal multiplying step of multiplying an output in said horizontal step and an output in said longitudinal detecting step;

a step of deducting an output in said horizontal multiplying step from said video signal;

a vertical step of extracting only a vertical high frequency component of said video signal;

a vertical multiplying step of multiplying an output in said vertical step and an output in said lateral detecting step; and

a step of deducting an output in said vertical multiplying step from said video signal, wherein

said block noise is eliminated according to said block noise level.

44. The recording medium according to any one of claims 39 to 43, further comprising a step of controlling a picture enhancement level emphasizing an outline of said video signal according to said block noise level detected in said step of detecting as to the longitudinal direction and said step of detecting as to the lateral direction.

45. The recording medium according to any one of claims 39 to 44, further comprising a step of specifying said video signal (types or quality thereof, for example) to be inputted in accordance with said block noise level detected in said step of detecting as to longitudinal direction and said step of detecting as to the lateral direction, wherein

in said specifying step, said specification result is on-screen-displayed on a screen in a predetermined format.

46. A recording medium containing a program recorded thereon, to be run in a computer device, for detecting block noise in the vertical or horizontal direction from a digital video signal subjected to lossy encoding on a predetermined image block basis caused by decoding the video signal, the program for realizing an operational environment on said computer device comprising the steps of:

extracting only a vertical or horizontal high frequency component of said video signal;

taking an absolute value of said extracted high frequency component signal;

accumulating/adding said absolute-value-taken high frequency component signal in the horizontal or vertical direction;

again extracting high frequency component from said accumulated/added high frequency component signal;

accumulating/adding a signal outputted in said step of again extracting high frequency component on a predetermined N-point basis (N is a positive integer);

detecting said block noise level of said video signal by computing the signal outputted in said step of again extracting high frequency component in the temporal direction;

determining a maximum value and a position thereof among N-piece accumulated/added values determined by said accumulation/addition; and

masking said detected block noise level at said position of the maximum value, and determining a vertical or horizontal block boundary corresponding to the position.

47. A recording medium containing a program recorded thereon, to be run in a computer device, for controlling a dot clock to be regenerated in a video processing system in which a digital video signal subjected to lossy encoding on a predetermined image block basis is processed, the program for realizing an operational environment on said computer device comprising the steps of:

receiving said video signal, and detecting, with respect to the video signal, a block boundary (where said block noise is generated) in the longitudinal direction on a screen; and

changing clock delay in such a manner that said block boundary detected in said step periodically has a single maximum point (peak) with respect to a clock generating device in which said dot clock used for said video processing system is generated based on a horizontal synchronizing pulse.

48. The recording medium according to claim 47, wherein said detecting step further comprises the steps of:

extracting only a horizontal high frequency component of said video signal;

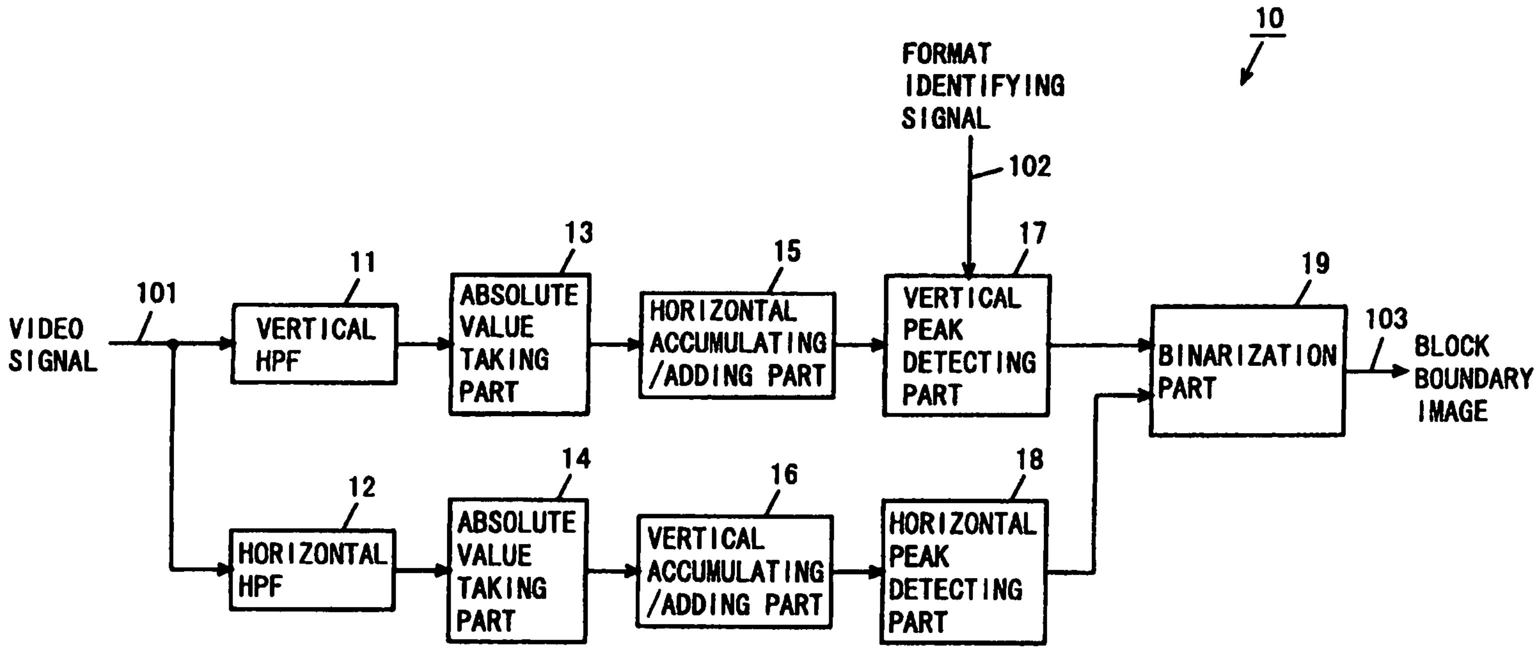
taking an absolute value of said extracted high frequency component signal;

accumulating/adding said absolute-value-taken high frequency component signal in the vertical direction;

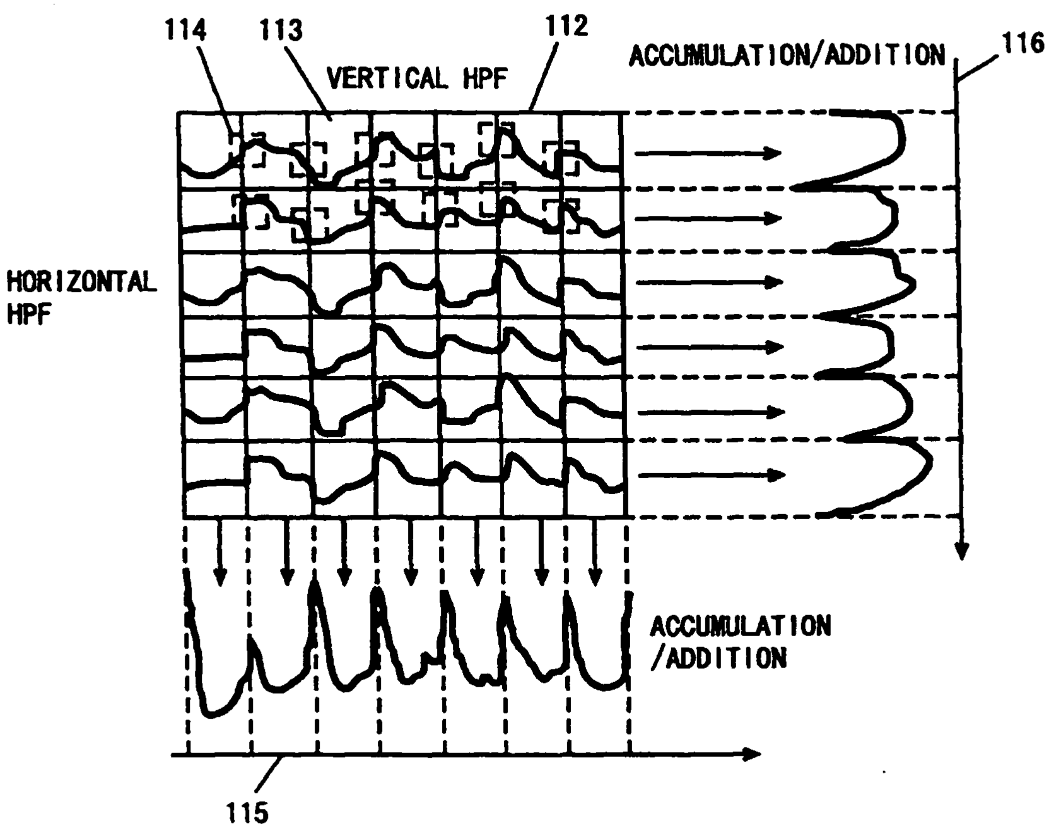
again extracting high frequency component from said accumulated/added high frequency component signal; and

accumulating/adding the signal outputted in said step of again extracting high frequency component on a predetermined N-point basis (N is a positive integer).

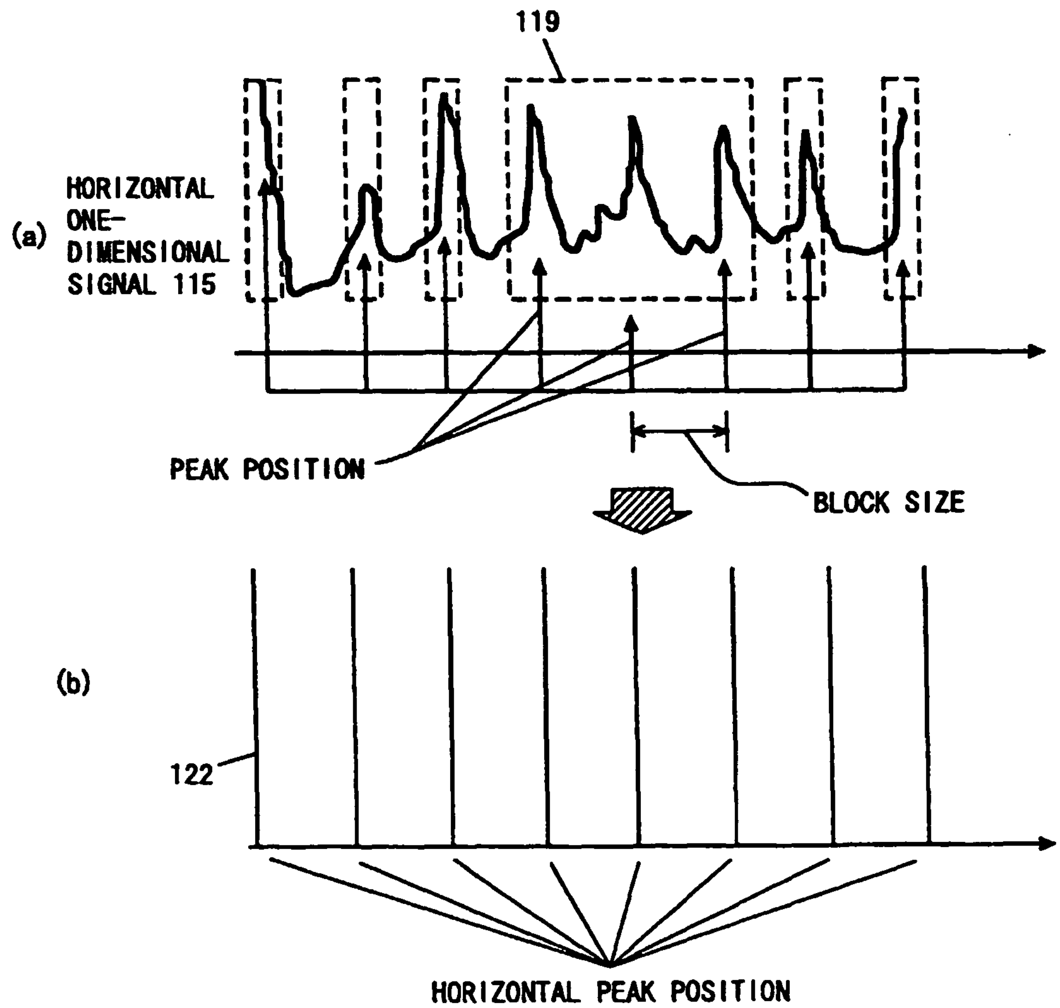
F I G. 1


10
VIDEO SIGNAL
101
VERTICAL HPF
11
HORIZONTAL HPF
12
ABSOLUTE VALUE TAKING PART
13
ABSOLUTE VALUE TAKING PART
14
HORIZONTAL ACCUMULATING /ADDING PART
15
VERTICAL ACCUMULATING /ADDING PART
16
FORMAT IDENTIFYING SIGNAL
102
VERTICAL PEAK DETECTING PART
17
HORIZONTAL PEAK DETECTING PART
18
BINARIZATION PART
19
103
BLOCK BOUNDARY IMAGE

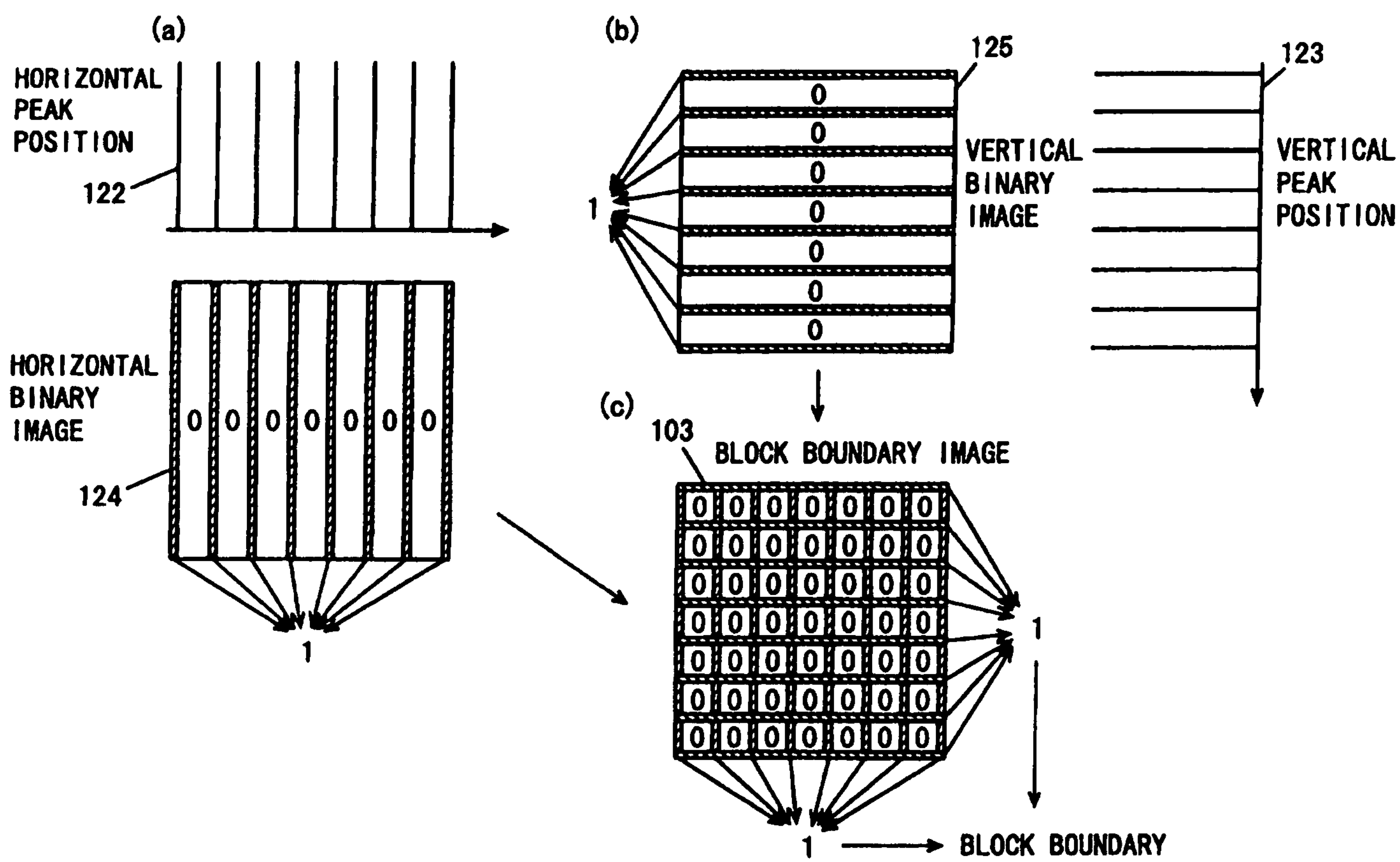
F I G. 2


114
113
112
VERTICAL HPF
ACCUMULATION/ADDITION
116
HORIZONTAL HPF
ACCUMULATION /ADDITION
115

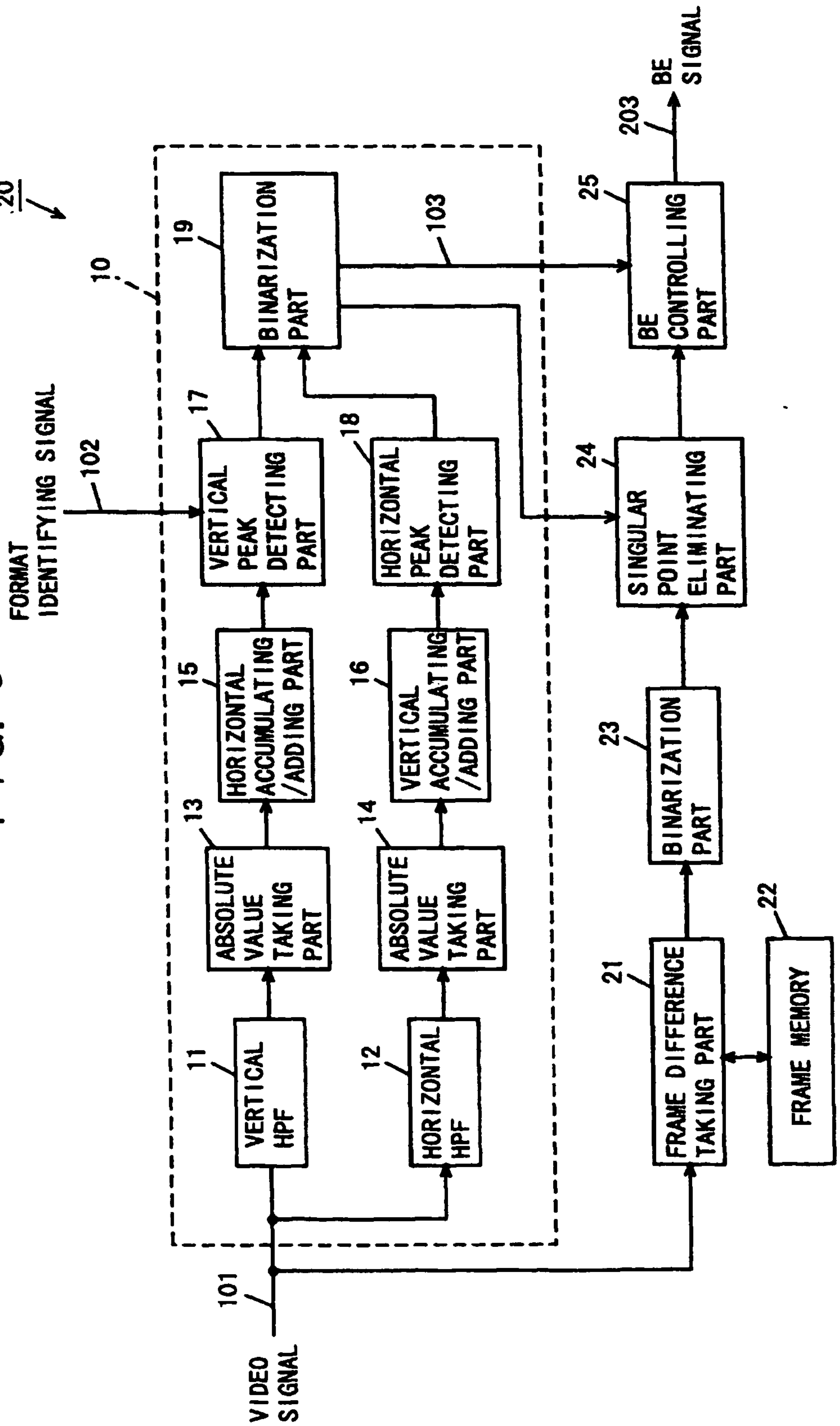
F I G. 3


119
(a)
HORIZONTAL ONE-DIMENSIONAL SIGNAL 115
PEAK POSITION
BLOCK SIZE
(b)
122
HORIZONTAL PEAK POSITION

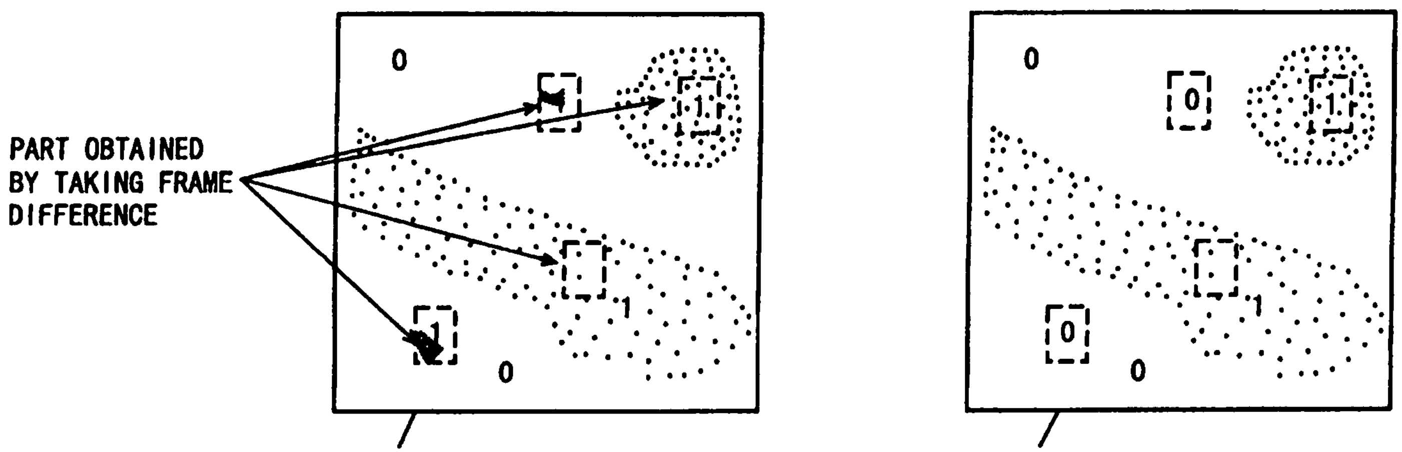
F I G. 4


(a)
HORIZONTAL PEAK POSITION
122
HORIZONTAL BINARY IMAGE
124
0 0 0 0 0 0 0
1
(b)
125
VERTICAL BINARY IMAGE
123
VERTICAL PEAK POSITION
1
(c)
103
BLOCK BOUNDARY IMAGE
1
1
BLOCK BOUNDARY

F I G. 5


20
VIDEO SIGNAL
101
FORMAT IDENTIFYING SIGNAL
102
10
11
VERTICAL HPF
12
HORIZONTAL HPF
13
ABSOLUTE VALUE TAKING PART
14
ABSOLUTE VALUE TAKING PART
15
HORIZONTAL ACCUMULATING /ADDING PART
16
VERTICAL ACCUMULATING /ADDING PART
17
VERTICAL PEAK DETECTING PART
18
HORIZONTAL PEAK DETECTING PART
19
BINARIZATION PART
103
21
FRAME DIFFERENCE TAKING PART
22
FRAME MEMORY
23
BINARIZATION PART
24
SINGULAR POINT ELIMINATING PART
25
BE CONTROLLING PART
203
BE SIGNAL

F I G. 6



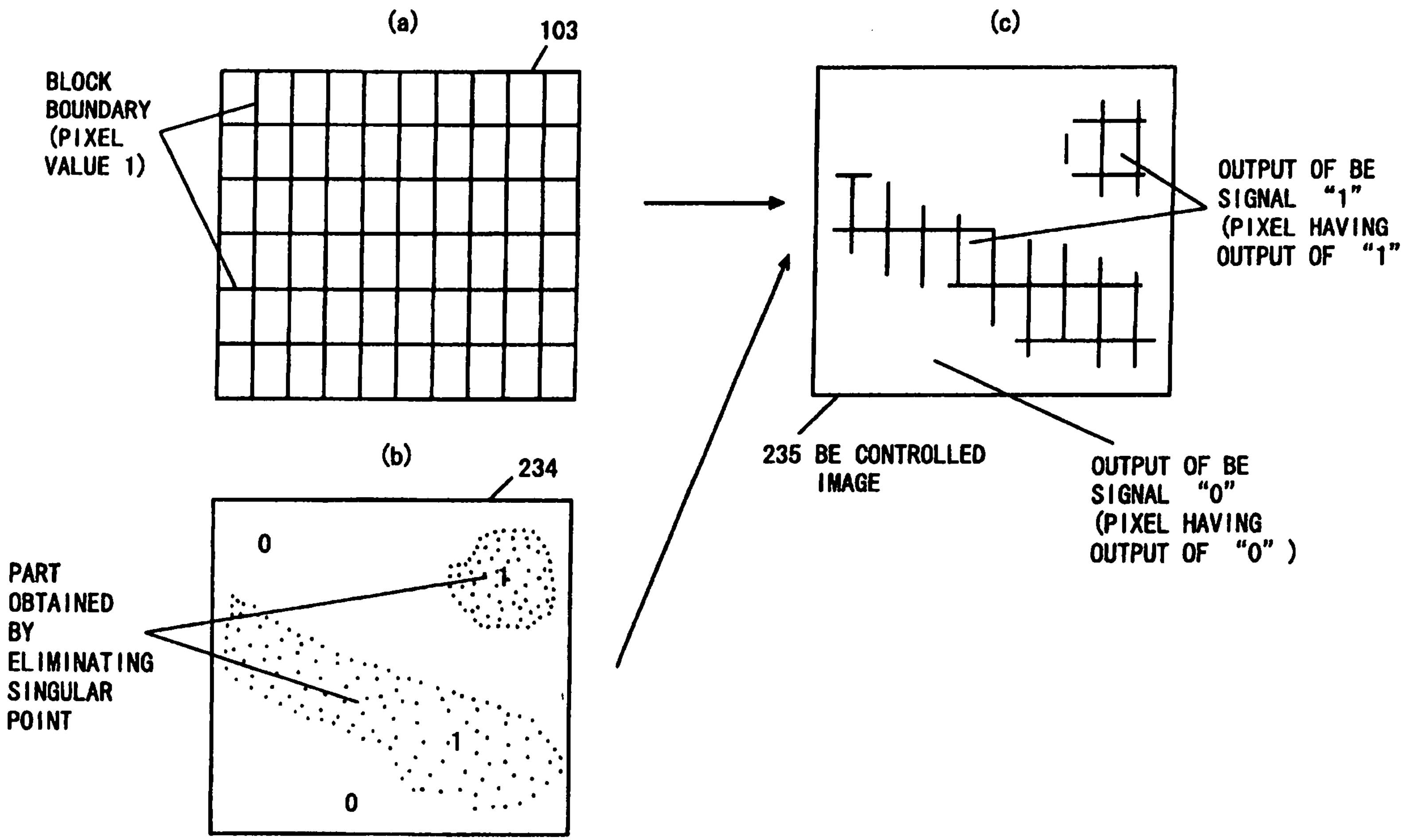
233 IMAGE BEFORE ELIMINATING SINGULAR POINT

(a)

234 IMAGE AFTER ELIMINATING SINGULAR POINT

(b)

F I G. 7


(a)
103
BLOCK BOUNDARY (PIXEL VALUE 1)
(b)
234
0
1
1
0
PART OBTAINED BY ELIMINATING SINGULAR POINT
(c)
OUTPUT OF BE SIGNAL "1" (PIXEL HAVING OUTPUT OF "1")
235 BE CONTROLLED IMAGE
OUTPUT OF BE SIGNAL "0" (PIXEL HAVING OUTPUT OF "0")

F I G. 8

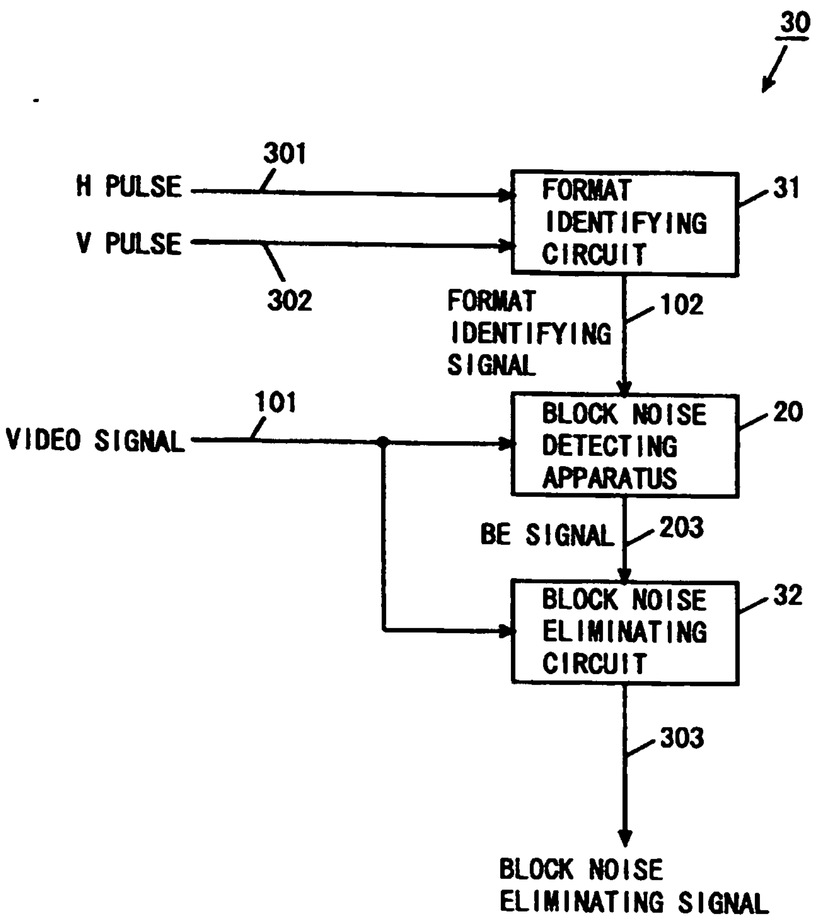

30
301
H PULSE
V PULSE
302
FORMAT IDENTIFYING CIRCUIT
31
FORMAT IDENTIFYING SIGNAL
102
101
VIDEO SIGNAL
BLOCK NOISE DETECTING APPARATUS
20
BE SIGNAL
203
BLOCK NOISE ELIMINATING CIRCUIT
32
303
BLOCK NOISE ELIMINATING SIGNAL

FIG. 9

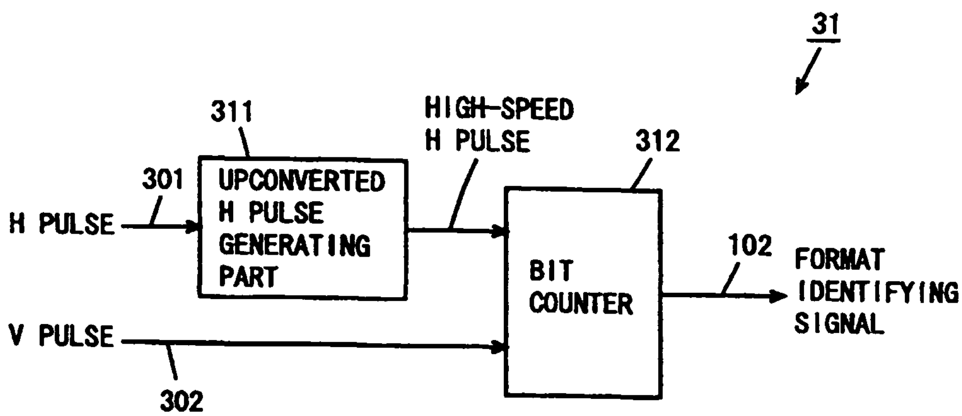
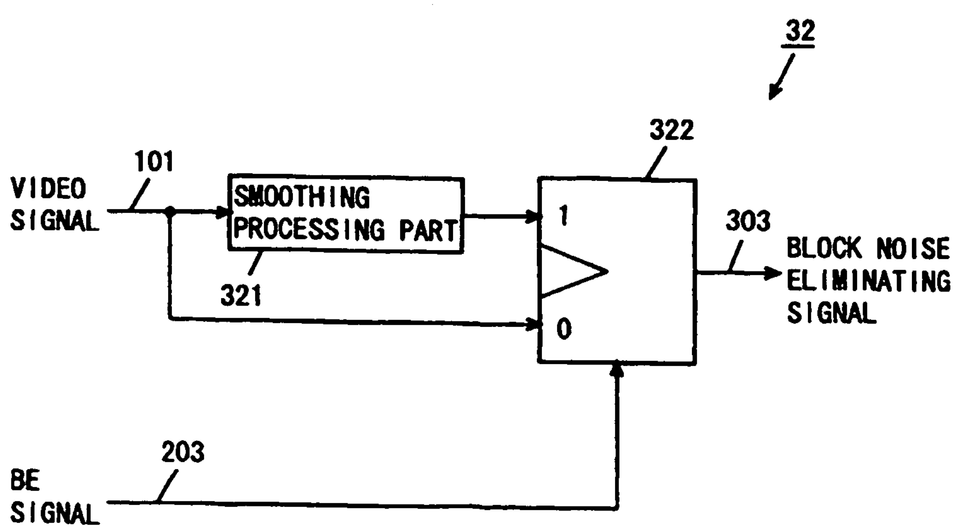

31
311
HIGH-SPEED
H PULSE
312
301
UPCONVERTED
H PULSE
GENERATING
PART
H PULSE
BIT
COUNTER
102
FORMAT
IDENTIFYING
SIGNAL
V PULSE
302

FIG. 10


32
322
101
VIDEO
SIGNAL
SMOOTHING
PROCESSING PART
1
303
BLOCK NOISE
ELIMINATING
SIGNAL
321
0
203
BE
SIGNAL

F I G. 1 1

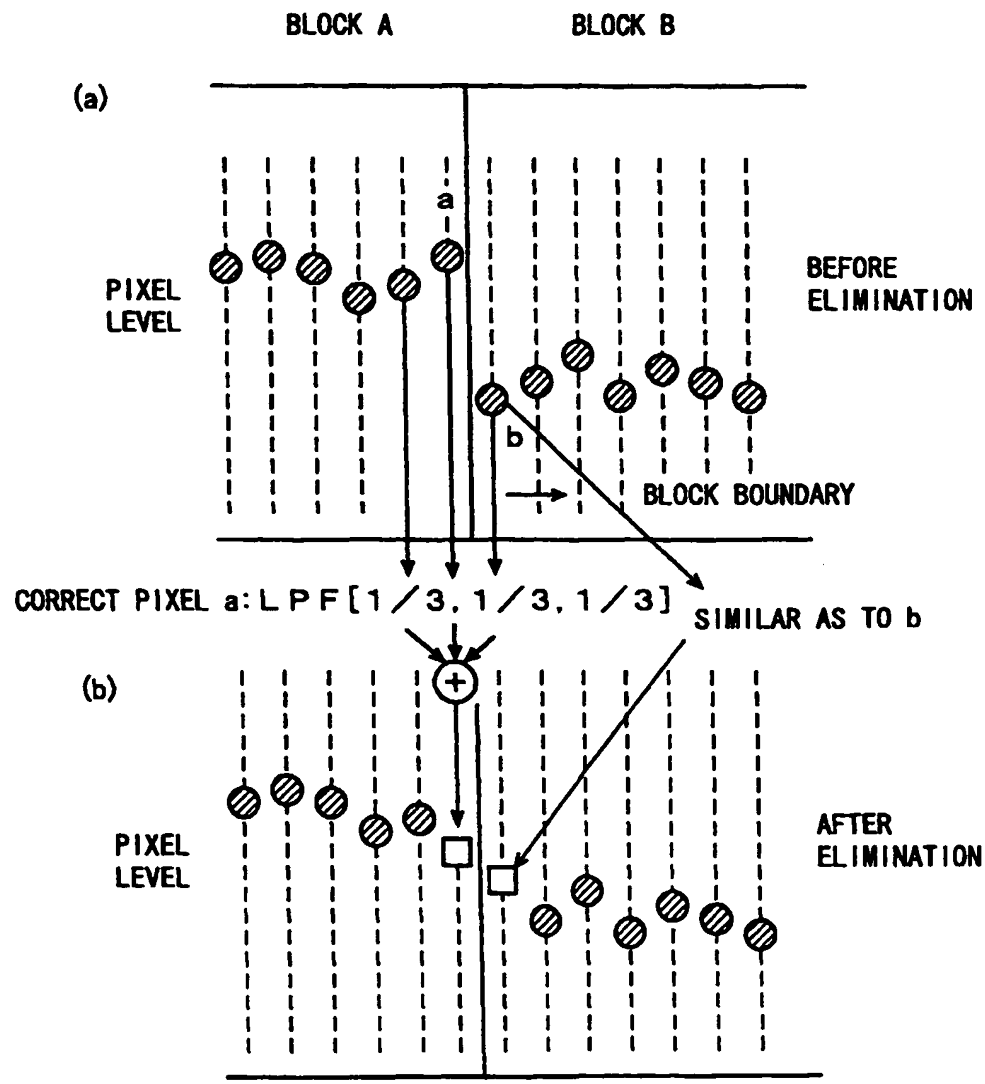

BLOCK A
BLOCK B
(a)
a
PIXEL LEVEL
BEFORE ELIMINATION
b
BLOCK BOUNDARY
CORRECT PIXEL a: L P F [1 / 3, 1 / 3, 1 / 3]
SIMILAR AS TO b
(b)
PIXEL LEVEL
AFTER ELIMINATION

FIG. 12

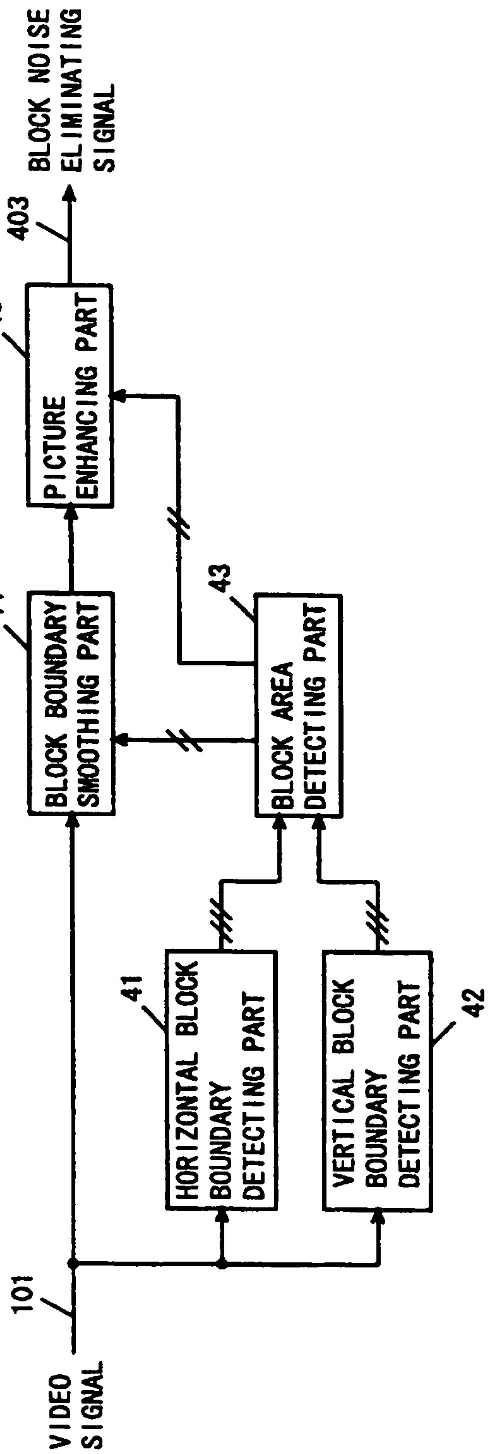

40
VIDEO SIGNAL
101
HORIZONTAL BLOCK BOUNDARY DETECTING PART
41
VERTICAL BLOCK BOUNDARY DETECTING PART
42
BLOCK AREA DETECTING PART
43
BLOCK BOUNDARY SMOOTHING PART
44
PICTURE ENHANCING PART
45
403
BLOCK NOISE ELIMINATING SIGNAL

FIG. 13

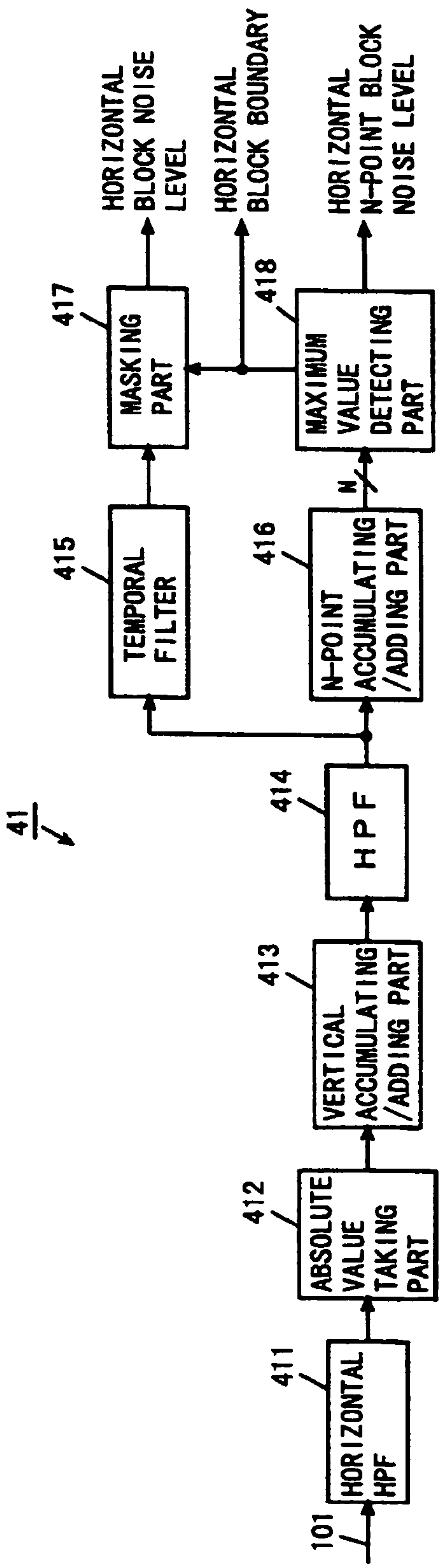

41
101
411
HORIZONTAL HPF
412
ABSOLUTE VALUE TAKING PART
413
VERTICAL ACCUMULATING /ADDING PART
414
HPF
415
TEMPORAL FILTER
416
N-POINT ACCUMULATING /ADDING PART
N
417
MASKING PART
418
MAXIMUM VALUE DETECTING PART
HORIZONTAL BLOCK NOISE LEVEL
HORIZONTAL BLOCK BOUNDARY
HORIZONTAL N-POINT BLOCK NOISE LEVEL

FIG. 14

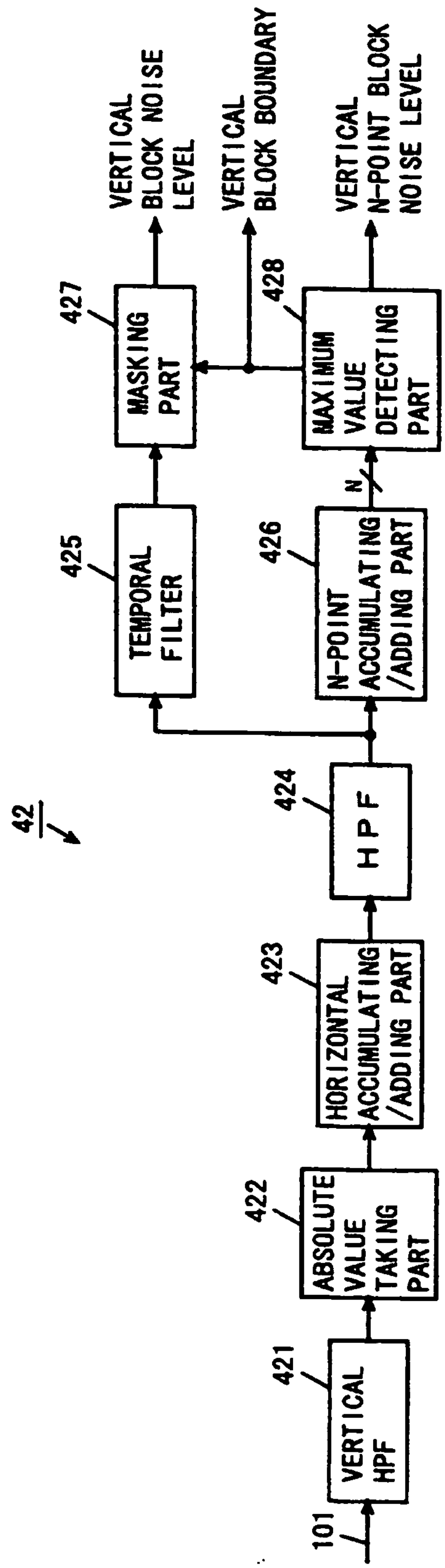

42
101
421
VERTICAL HPF
422
ABSOLUTE VALUE TAKING PART
423
HORIZONTAL ACCUMULATING /ADDING PART
424
HPF
425
TEMPORAL FILTER
426
N-POINT ACCUMULATING /ADDING PART
N
427
MASKING PART
428
MAXIMUM VALUE DETECTING PART
VERTICAL BLOCK NOISE LEVEL
VERTICAL BLOCK BOUNDARY
VERTICAL N-POINT BLOCK NOISE LEVEL

FIG. 15

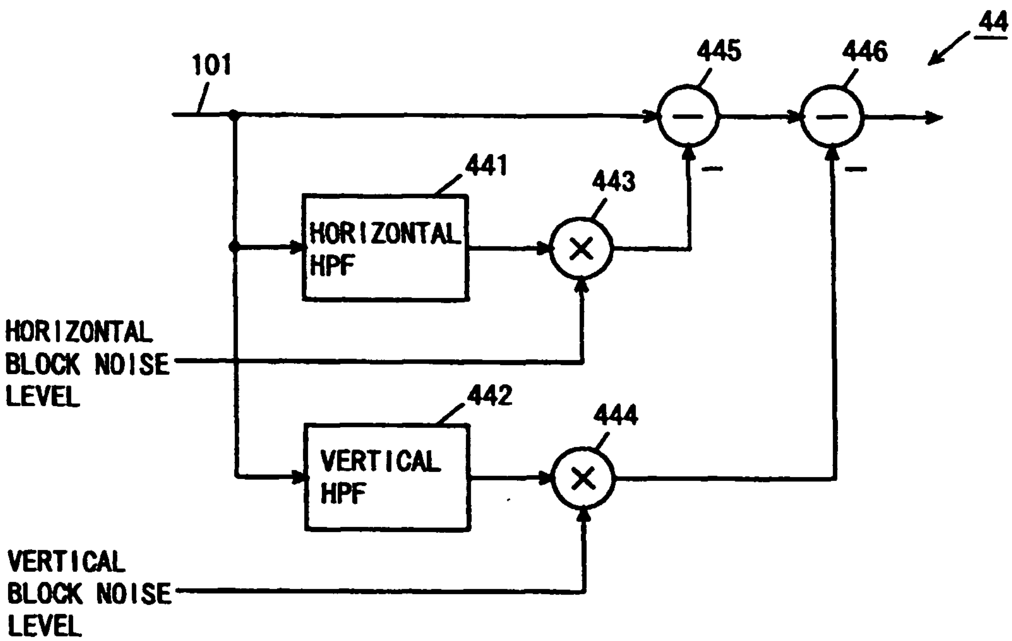

44
101
445
446
441
443
HORIZONTAL HPF
HORIZONTAL BLOCK NOISE LEVEL
442
444
VERTICAL HPF
VERTICAL BLOCK NOISE LEVEL

FIG. 16

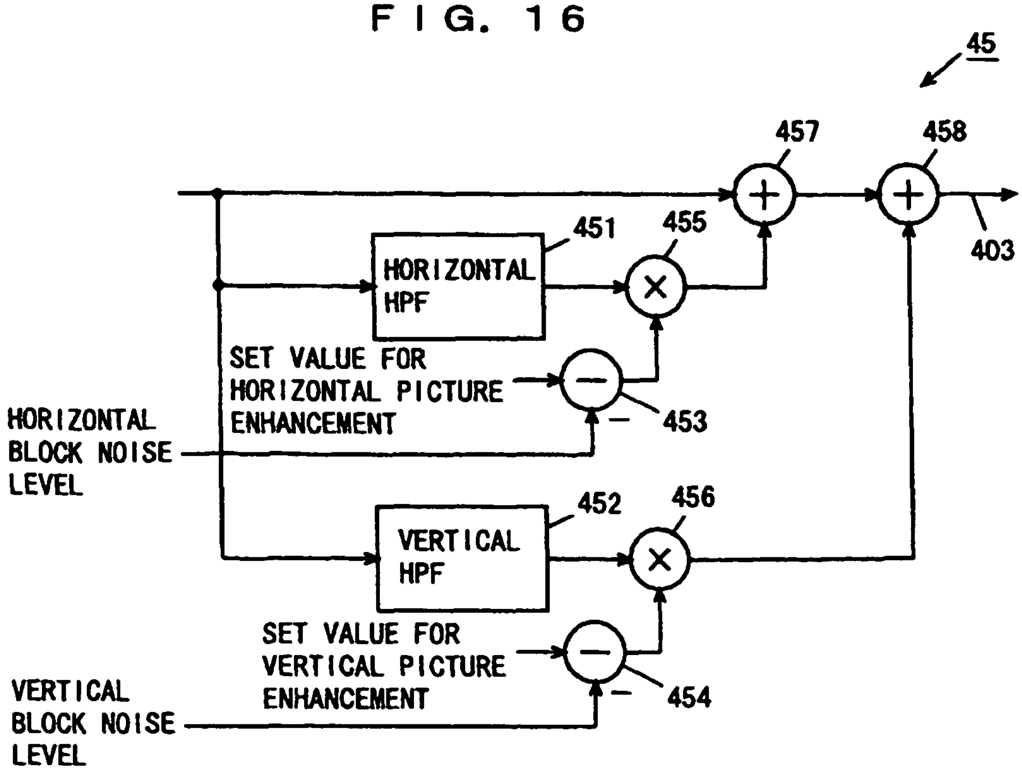

45
457
458
451
455
403
HORIZONTAL HPF
SET VALUE FOR HORIZONTAL PICTURE ENHANCEMENT
453
HORIZONTAL BLOCK NOISE LEVEL
452
456
VERTICAL HPF
SET VALUE FOR VERTICAL PICTURE ENHANCEMENT
454
VERTICAL BLOCK NOISE LEVEL

FIG. 17

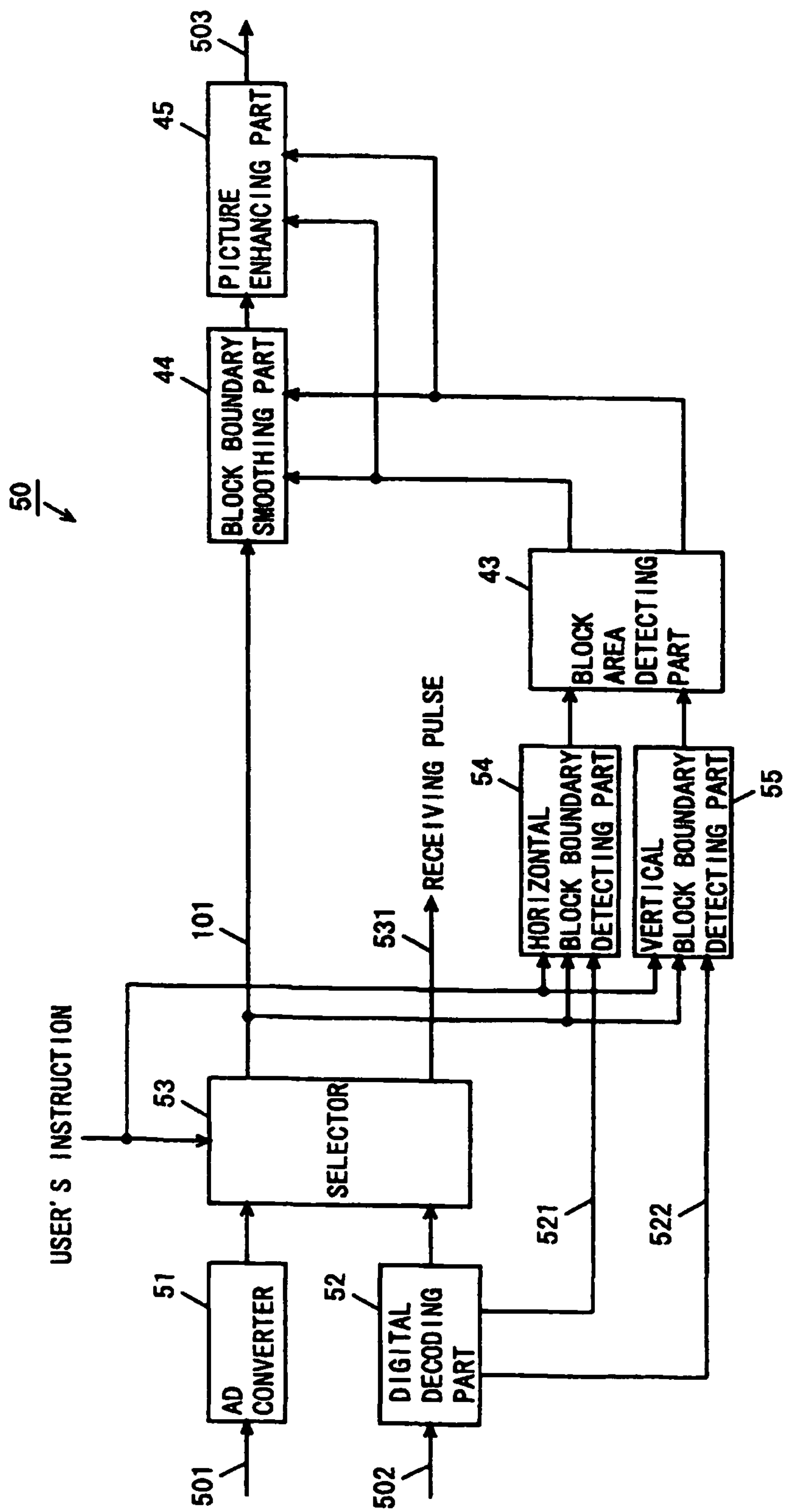
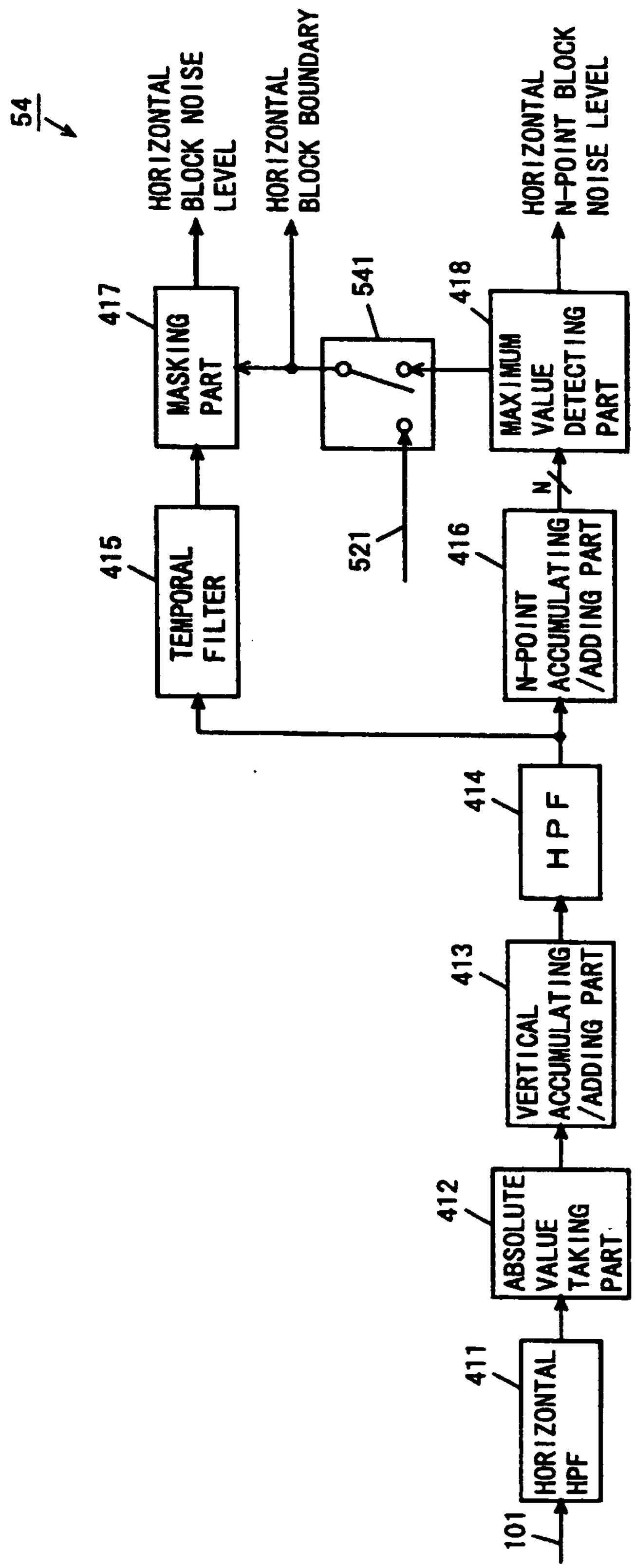

50
501
AD CONVERTER
51
502
DIGITAL DECODING PART
52
USER'S INSTRUCTION
SELECTOR
53
521
522
101
531
RECEIVING PULSE
HORIZONTAL BLOCK BOUNDARY DETECTING PART
54
VERTICAL BLOCK BOUNDARY DETECTING PART
55
BLOCK AREA DETECTING PART
43
BLOCK BOUNDARY SMOOTHING PART
44
PICTURE ENHANCING PART
45
503

FIG. 18


54
101
HORIZONTAL HPF
411
ABSOLUTE VALUE TAKING PART
412
VERTICAL ACCUMULATING /ADDING PART
413
HPF
414
TEMPORAL FILTER
415
N-POINT ACCUMULATING /ADDING PART
416
MASKING PART
417
MAXIMUM VALUE DETECTING PART
418
N
521
541
HORIZONTAL BLOCK NOISE LEVEL
HORIZONTAL BLOCK BOUNDARY
HORIZONTAL N-POINT BLOCK NOISE LEVEL

F I G. 1 9

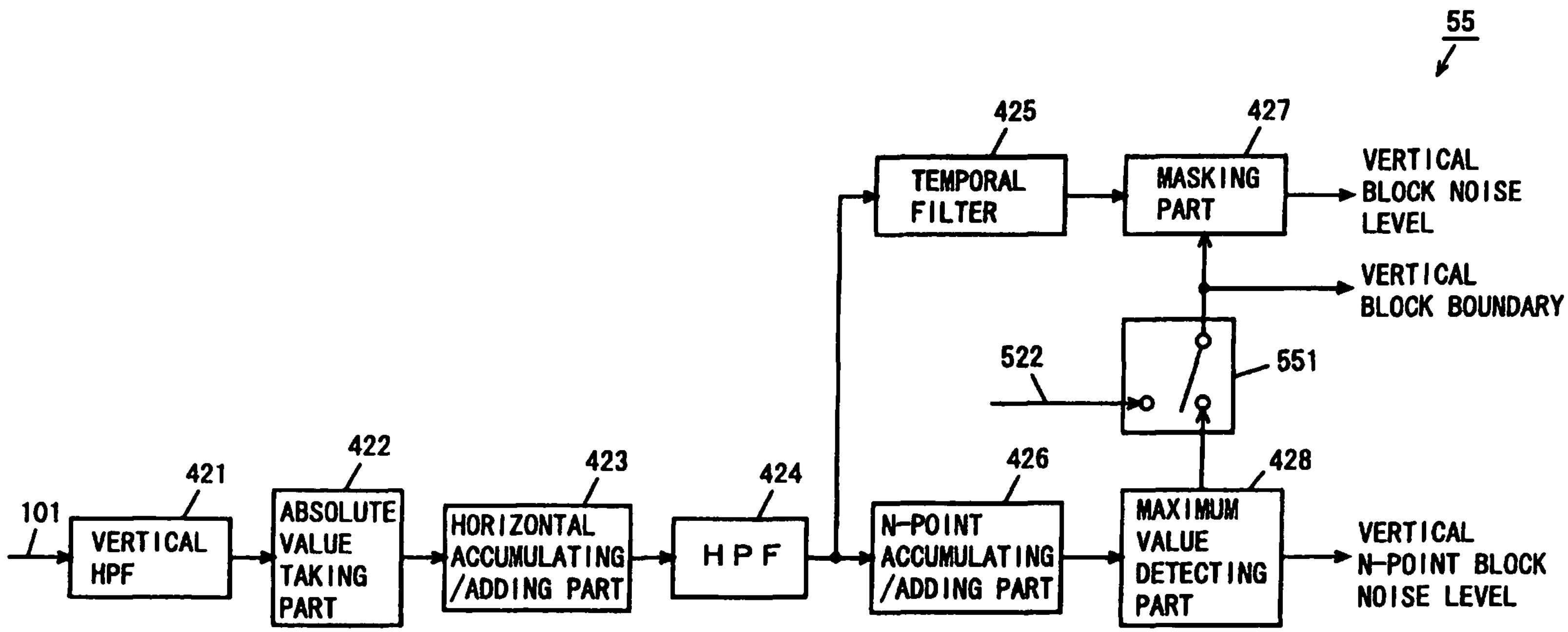

55
101
421
VERTICAL HPF
422
ABSOLUTE VALUE TAKING PART
423
HORIZONTAL ACCUMULATING /ADDING PART
424
HPF
425
TEMPORAL FILTER
426
N-POINT ACCUMULATING /ADDING PART
427
MASKING PART
428
MAXIMUM VALUE DETECTING PART
522
551
VERTICAL BLOCK NOISE LEVEL
VERTICAL BLOCK BOUNDARY
VERTICAL N-POINT BLOCK NOISE LEVEL

FIG. 20

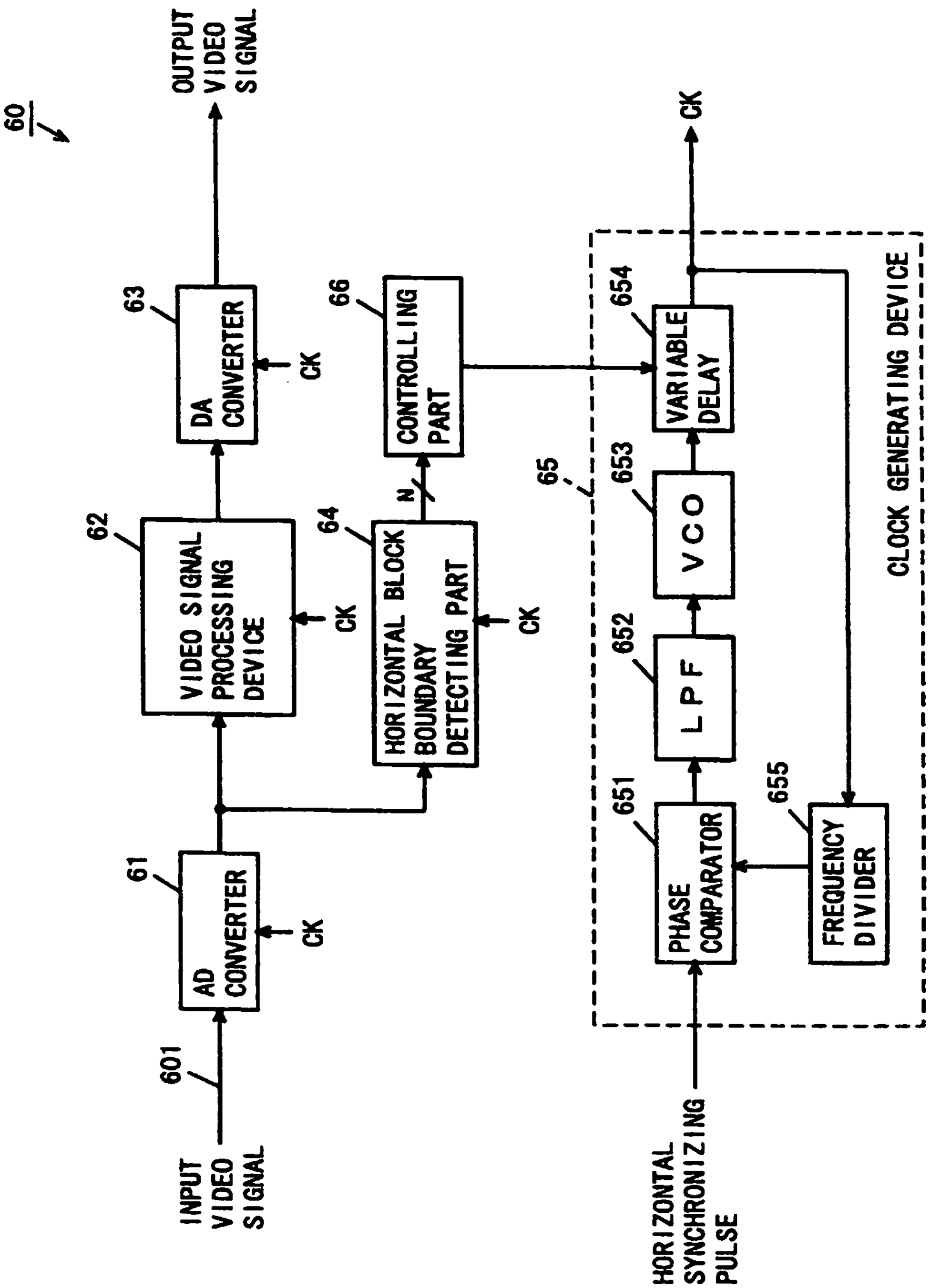
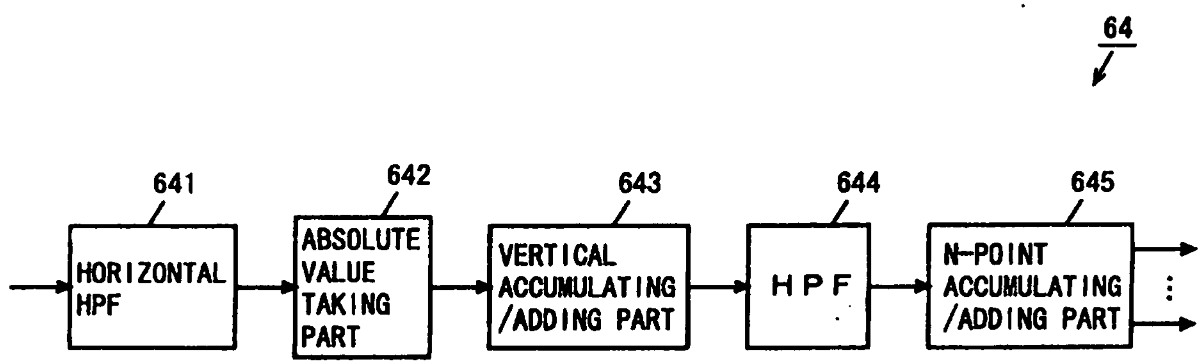
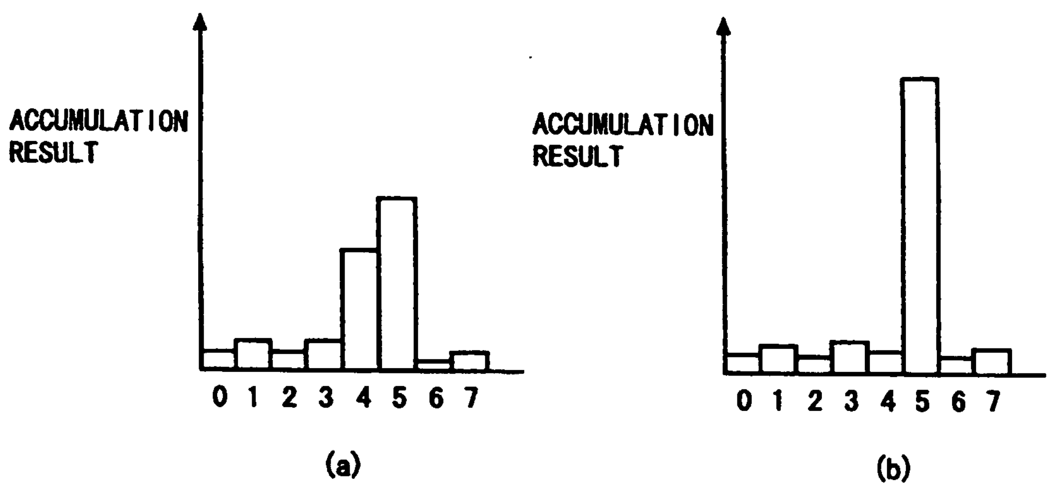

60
INPUT VIDEO SIGNAL
601
61
AD CONVERTER
CK
62
VIDEO SIGNAL PROCESSING DEVICE
CK
63
DA CONVERTER
CK
OUTPUT VIDEO SIGNAL
64
HORIZONTAL BLOCK BOUNDARY DETECTING PART
CK
N
66
CONTROLLING PART
65
HORIZONTAL SYNCHRONIZING PULSE
651
PHASE COMPARATOR
652
LPF
653
VCO
654
VARIABLE DELAY
655
FREQUENCY DIVIDER
CK
CLOCK GENERATING DEVICE

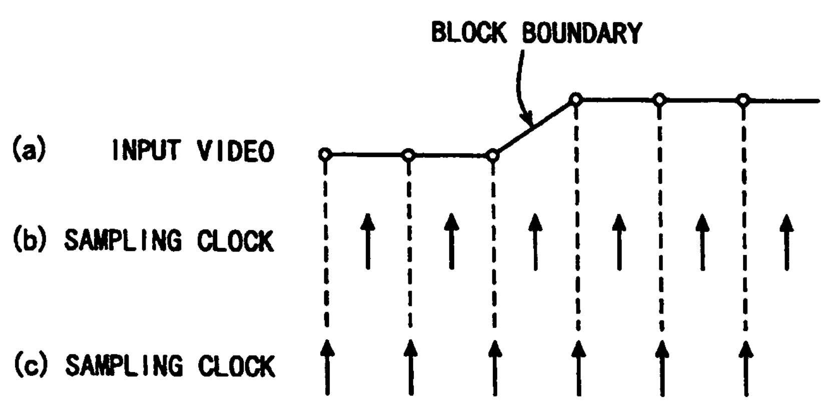
FIG. 21


64
641
HORIZONTAL HPF
642
ABSOLUTE VALUE TAKING PART
643
VERTICAL ACCUMULATING /ADDING PART
644
HPF
645
N-POINT ACCUMULATING /ADDING PART

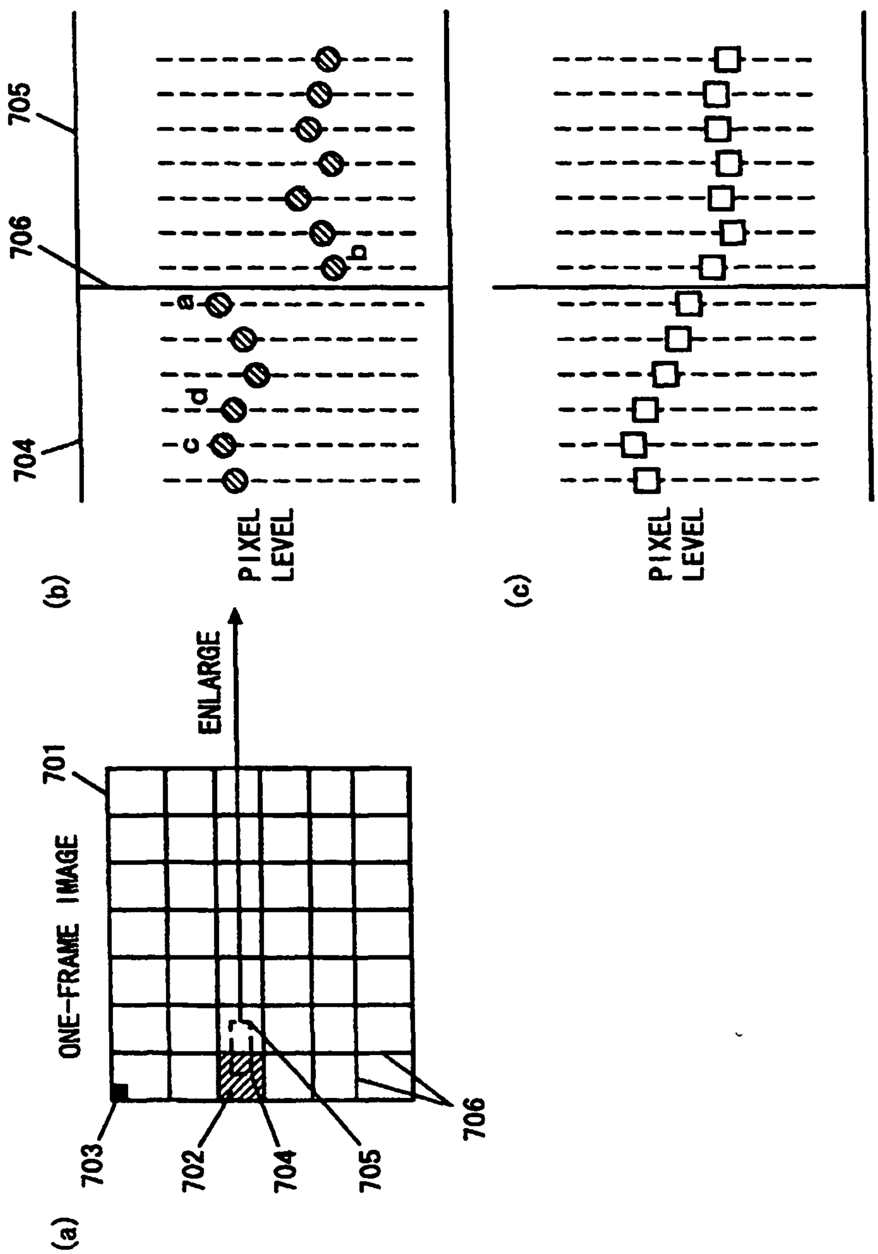
F I G. 2 2


ACCUMULATION RESULT
0 1 2 3 4 5 6 7
(a)
ACCUMULATION RESULT
0 1 2 3 4 5 6 7
(b)

F I G. 2 3


BLOCK BOUNDARY
(a) INPUT VIDEO
(b) SAMPLING CLOCK
(c) SAMPLING CLOCK

F I G. 2 4


(a)
ONE-FRAME IMAGE
701
703
702
704
705
706
ENLARGE
(b)
PIXEL LEVEL
704
706
705
a
b
c
d
(c)
PIXEL LEVEL

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP99/02589

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl^6 H04N7/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl^6 H04N7/24-7/68, H04N1/41-1/419

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1957-1996 Toroku Jitsuyo Shinan Koho 1996-1999
Kokai Jitsuyo Shinan Koho 1973-1999

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
JICST File (JOIS)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	JP, 9-247672, A (Matsushita Electric Industrial Co., Ltd.), 19 September, 1997 (19. 09. 97) (Family: none)	1, 10 2-9, 11-48
Y A	JP, 3-46482, A (Kokusai Denshin Denwa Co., Ltd.), 27 February, 1991 (27. 02. 91) (Family: none)	1, 10 2-9, 11-48
Y A	JP, 4-180381, A (Matsushita Electric Industrial Co., Ltd.), 26 June, 1992 (26. 06. 92) (Family: none)	1, 10 2-9, 11-48

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Date of the actual completion of the international search	Date of mailing of the international search report
9 August, 1999 (09. 08. 99)	24 August, 1999 (24. 08. 99)
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